Phonetics Analytics in DROP

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Phonetics – Introduction

Overview

1. Definition of Phonetics and Phoneticians: *Phonetics* is a branch of linguistics that studies how humans perceive and product sounds, or in the case of sign languages, the equivalent aspects of sign (O'Grady (2005), Wikipedia (2021)). Phoneticians – linguists who specialize in phonetics – study the physical properties of speech.
2. Disciplines that Comprise Phonetics Study: The field of phonetics is traditionally divided into three sub-disciplines based on the research questions involved such as how humans plan and execute movements to produce speech – articulatory phonetics; how different movements affect the properties of the resulting sound – acoustic phonetics; or how humans convert sound waves to linguistic movements – auditory phonetics.
3. Minimal Linguistic vs Phonological Unit: Traditionally, the minimal linguistic unit of phonetics has been the phone – a speech sound in a language – which differs from the minimal phonological unit of phoneme; the phoneme is an abstract categorization of phones.
4. Speech Perception/Production in Languages: Phonetics broadly deals with two aspects of human speech; a) the way humans make sounds, and b) perception – the way speech is understood. The communication modality of a language describes the method by which a language produces and perceives speech.
5. Languages with Oral-Aural Modalities: Languages with oral-aural modalities such as English produce speech orally; i.e., using the mouth, and perceive speech aurally – using the ears.
6. Languages with Manual Visual Modalities: Sign languages, such Auslan and ASL, have a manual-visual modality, producing speech manually – using the hands – and perceiving speech visually – using the eyes.

7. Languages with Tactile Signing Modality: ASL and some other sign languages in addition have a manual-manual dialect for use in tactile signing in deafblind speakers where the signs are produced by the hands and perceived by the hands as well.
8. Non-linguistic to Speech Translation: Language production consists of several independent processes which transform a non-linguistic message into a spoken or signed linguistic signal.
9. Lexical Selection - Choosing Word Items: After identifying a message to be linguistically encoded, a speaker must select the individual words – known as lexical items – to represent that message in a process called lexical selection.
10. Assignment of Words to Phonemes: During phonological encoding, the mental representation of the words is assigned their phonological content as a sequence of phonemes to be produced. These phonemes are specified for articulatory features which denote particular goals such as closed lips or the tongue in a particular position.
11. Phonemes as Muscle Command Sequence: These phonemes are then coordinated into a sequence of muscle commands that can be sent to muscles, and when these commands are executed properly the intended sounds are produced.
12. Airstream Disruption/Modification using Articulators: These movements disrupt and modify an airstream which results in a sound wave. The modification is done by articulators, with different places and manners of articulation producing different results.
13. Places and Manner of Articulation: For example, the words *task* and *sack* both begin with alveolar sounds in English, but differ in how far the tongue is from the alveolar ridge. The difference has large effects on the airstream and thus the sound that is produced. Similarly, the direction and the source of the airstream can affect the sound.
14. Pulmonic/Glottal/Lingual Airstream Modification: The most common airstream mechanism is pulmonic – using the lungs – but the glottis and the lungs can also be used to produce airstreams.
15. Decoding Signals into Linguistic Units: Language perception is the process by which a linguistic signal is decoded and understood by the listener. In order to perceive speech, the continuous acoustic signal must be converted into discrete linguistic units such as phonemes, morphemes, and words.

16. Detection of the Linguistic Categories: In order to correctly identify and categorize sounds, listeners prioritize certain aspects of the signal that can reliably distinguish between linguistic categories.
17. Visual Information Augmenting Acoustic Cues: While certain cues are prioritized over others, many aspects of the signal can contribute to perception. For example, though oral languages prioritize acoustic information, the McGurk effect shows that the visual information is used to distinguish ambiguous information when acoustic ones are unreliable.
18. Articulatory Phonetics: Modern phonetics has three main branches. The first, articulatory phonetics, studies the way sounds are made with the articulators.
19. Acoustic Phonetics: This studies the acoustic results of different articulations.
20. Auditory Phonetics: This studies the way listeners perceive and understand linguistic signals.

Production

1. Sequential Steps of Speech Production: Language production consists of several inter-dependent processes which transform a non-linguistic message into a spoken or signed linguistic signal. Linguists debate whether the process of language production occurs in a series of stages, i.e., serial processing, or whether production processes occur in parallel.
2. Linguistic Encoding through Lexical Selection: After identifying the message to be linguistically encoded, a speaker must select the individual words – known as lexical items – to represent that message in a process called lexical selection.
3. Word's Lemma - Semantic/Grammatic Determination: The words are selected based on their meaning, which in linguistics is called semantic information. Lexical selection activates the word's lemma, which contains both semantic and grammatic information about the word (Dell and O'Seaghdha (1992)). Again, linguists debate whether these stages can interactor whether they occur serially – for e.g., compare Motley, Camden, and Baars (1982) with Dell and O'Seaghdha (1992). For ease of description, the language production process is this chapter is described as a series of independent stages, though recent evidence shows that this

is inaccurate (Sedivy (2019)). Jaeger, Furth, and Hilliard (2012) contain further description of the interactive activation models.

4. Transferring Lexical Words to Phonemes: After an utterance has been planned – or after part of an utterance has been planned (Gleitman, January, Nappa, Trueswell (2007) provide evidence for production before a message has been completely planned), it then goes through phonological encoding. In this stage of language production, the mental representation of the words is assigned their phonological content as a sequence of phonemes.
5. Transformation to Muscle Movement Commands: The phonemes are specified for articulatory features which denote particular goals such as closed lips or tongue in a particular location. These phonemes are then coordinated into a sequence of muscle commands that can be sent to the muscles, and when these commands are executed properly the intended sound are produced (Boersma (1998)).
6. Message To Sound Transformation Summary: Thus, the process of production from message to sound can be summarized as the following sequence (Boersma (1998), Sedivy (2019)):
    a. Message Planning
    b. Lemma Selection
    c. Retrieval and Assignment of Phonological Word Forms
    d. Articulatory Specification
    e. Muscle Commands
    f. Articulation
    g. Speech Sounds

Place of Articulation

1. Phonetic Definition of a Consonant: Sounds that are made by a full or a partial constriction of the vowel tract are called consonants. Consonants are produced in the vocal tract, usually the mouth, and the location of this constriction affects the resulting sound.

2. Tongue Position Impact on Sound: Because of the close connection between the position of the tongue and the resulting sound, the place of articulation is an important concept in many sub-disciplines of phonetics.
3. Constriction Articulator and its Location: Sounds are partly categorized by the location of the constriction as well as the part of the body doing the constricting. For example, in English the words *fought* and *thought* are a minimal pair differing only in the organ making the constriction rather than the location of the constriction.
4. Example: Labiodental vs. Linguolabial Articulation: The *f* in *fought* is a labiodental articulation made with the bottom lip against the teeth. The *th* in *thought* is a linguolabial articulation made by the tongue against the teeth. Constrictions made by the lips are called labials while those made with the tongue are called linguals.
5. Places of Articulation on Tongue: Constrictions made in the tongue can be made in several parts of the vocal tract, broadly classified into coronal, dorsal, and radical places of articulation. Coronal articulations are made with the front of the tongue, dorsal articulations are made with the body of the tongue, and radical articulations are made in the pharynx (Ladefoged and Johnson (2011)).
6. Fine Grained Places of Articulation: These divisions are not sufficient for distinguishing and describing all speech sounds (Ladefoged and Johnson (2011)). For example, in English sounds [*s*] and [ʃ] are both coronal, but they are produced are different places in the mouth. To account for this, more detailed places of articulation are needed based upon the area of the mouth in which the constriction occurs (Ladefoged and Maddieson (1996)).

Labial

1. Three Types of Labial Articulators: Articulators involving lips can be made in three different ways: with both lips (bilabial), with one lip and the teeth (labiodental), and with the teeth and the upper lip (linguolabial) (Ladefoged and Maddieson (1996)). Depending on the definition

used, some or all kinds of articulations can be categorized into the class of labial articulations.

2. <u>Lip Movements in Bilabial Consonants</u>: Bilabial consonants are made with both lips. In producing these sounds the lower lip moves farthest to meet the upper lip, which also moves down slightly (Maddieson (1993)), though in some cases the force from the sir moving from the aperture – the opening between the lips – may cause the lips to separate faster than they can come together (Fujimura (1961)).
3. <u>Incomplete Closures using Bilabial Articulators</u>: Unlike most other articulations, both articulators are made from soft issue, and so bilabial stops are more likely to be produced with incomplete closures than articulations involving hard surfaces like teeth or palate.
4. <u>Active Movement of the Upper Articulator</u>: Bilabial stops are also unusual in that an articulator in the upper section of the vocal tract actively moves downwards, as the upper lip shows some active downward movement (Ladefoged and Maddieson (1996)).
5. <u>Lip Movements in Linguolabial Consonants</u>: Linguolabial consonants are made with the blade of the tongue approaching and contacting the upper lip. As in bilabial articulations, the upper lip moves slightly towards the mor active articulator.
6. <u>IPA Symbols for Linguolabial Consonants</u>: Articulations in this group do not have their own symbols in the International Phonetic Alphabet, rather, they are formed by combining an apical symbol with a diacritic implicitly placing them in the coronal category (Ladefoged and Maddieson (1996), International Phonetic Association (2015)). They exist in a number of languages indigenous to Vanuatu such as Tangoa.
7. <u>Lip Movements in Labial Consonants</u>: Labiodental consonants are made by the lower lip rising to the upper teeth. Labiodental consonants are most often fricatives while labiodental nasals are also typically common (Ladefoged and Maddieson (1996)).
8. <u>Occurrence of True Labiodental Plosives</u>: There is a debate as to whether true labiodental plosives occur in an any natural languages, though a number of languages are reported to have labiodental plosives including Zulu (Doke (1926)), Tonga (Guthrie (1948)), and Shubi (Ladefoged and Maddieson (1996)).

Coronal

1. Tongue Positions of Coronal Consonants: Coronal consonants are made with the tip or the blade of the tongue and, because of the agility of the front of the tongue, represent a variety not only in place but also in the posture of the tongue.
2. Coronal Consonants Places of Articulation: The coronal places of articulation represent the areas of the mouth where the tongue contacts of makes a constriction, and include dental, alveolar, and post-alveolar locations.
3. Apical vs Laminal Tongue Posture: Tongue postures using the tip of the tongue can be apical if using the top of the tongue tip, laminal if made with the blade of the tongue, or sub-apical if the tongue tip is curled back and the bottom of the tongue is used.
4. Widespread Coronal Manner of Articulation: Coronals are unique as a group in that every manner of articulation is attested (Ladefoged and Maddieson (1996), International Phonetic Association (2015)). Australian languages are well-known for a large number of coronal contrasts exhibited within and across languages in the region (Ladefoged and Maddieson (1996)).
5. Production/Classification of Dental Consonants: Dental consonants are made with the tip or the blade of the tongue and the upper teeth. They are divided into two groups based upon the part of the tongue used to produce them: apical dental consonants are produced with the tongue touching the teeth; interdental consonants are produced with the blade of the tongue as the tip of the tongue sticks out in front of the teeth. No language is known to use both contrastively though they can exist allophonically.
6. Production of the Alveolar Consonants: Alveolar consonants are made with the tip or the blade of the tongue at the alveolar ridge just behind the teeth and can similarly be apical or laminal (Ladefoged and Maddieson (1996)).
7. Variations among Dental/Alveolar Consonants: Cross-linguistically, dental consonants and alveolar consonants are frequently contrasted leading to a number of generalizations of cross-linguistic patterns. The different places of articulation also tend to be contrasted in the part of the tongue used to produce them: most languages with dental stops have laminal dentals, while languages with apical stops usually have apical dentals.

8. Laminality Based Contrast in Languages: Languages rarely have two consonants in the same place with a contrast in laminality, though Taa (!*Xóõ*) is a counter-example to this pattern (Ladefoged and Maddieson (1996)).
9. Mutually Exclusive Dental/Alveolar Stops: If a language has only one of a dental or an alveolar stop, it will usually be laminal if it is a dental stop, and the stop will usually be apical if it is an alveolar stop, though for example Temne and Bulgarian (Scatton (1984)) do not follow this pattern (Ladefoged and Maddieson (1996)).
10. Languages with Dental/Alveolar Stops: If a language has both an apical and a laminal stop, the laminal stop is more likely to be affricated as in Isoko, though Dahalo shows the opposite pattern with alveolar stops being more affricated (Ladefoged and Maddieson (1996)).
11. Varying Definitions of Retroflex Consonants: Retroflex consonants have several different definitions depending on whether the position of the tongue or the position of the roof is given prominence.
12. Retroflex Consonants Articulatory Roof Positions: In general, they represent a group of articulations in which the tip of the tongue is curled up to some degree. In this way retroflex articulations can occur in several different locations on the roof of the mouth including alveolar, post-alveolar, and palatal regions.
13. Retroflex from Underside of Tongue: If the underside of the tongue tip makes contact with the roof of the mouth, it is sub-apical though apical post-alveolar sounds are also described as retroflex (Ladefoged and Maddieson (1996)).
14. Presence of Sub-apical Retroflex Sounds: Typical examples of sub-apical retroflex stops found in Dravidian languages, and in some languages indigenous to the Southwest United States. The contrastive difference between dental and alveolar stops is the slight retroflexion on the alveolar stops (Ladefoged and Maddieson (1996)). Acoustically, retroflexion tends to affect the higher formants.
15. Articulations behind the Alveolar Ridge: Articulations taking place just behind the alveolar ridge, known as post-alveolar consonants, have been referred to using a number of different terms.
16. Post-alveolar and Laminal Articulations: Apical post-alveolar consonants are often called retroflex, while laminal articulations are sometimes called post-alveolar; in the Australianist literature, these laminal stops are often described as *palatal* though they are produced further

forward than the palate region typically described as palatal (Ladefoged and Maddieson (1996)).

17. Imprecise Nature of Alveolar Stops: Because of individual anatomical variation, the precise articulation of palate-alveolar stops – and coronals in general – can vary within a speech community (Ladefoged and Maddieson (1996)).

Dorsal

1. Three Types of Dorsal Consonants: Dorsal consonants are those consonants made by the tongue body rather than the tip or the blade, and are typically produced at the palate, the velum, or the uvula.
2. Palatal Consonant and Dorsal Contrasts: Palatal consonants are made using the tongue body against the hard palate on the roof of the mouth. They are frequently contrasted with velar or uvular consonants, though it is rare for a language to contrast all three simultaneously, with Jaqaru as a possible example of a three-way contrast (Ladefoged and Maddieson (1996)).
3. Velar Consonants and their Occurrence: Velar consonants are made using the tongue body against the velum. They are incredibly common cross-linguistically; almost all languages have a velar stop.
4. Coarticulation among Velars and Vowels: Because both velars and vowels are made using the tongue body, they are highly affected by coarticulation with vowels and can be produced as far forward as the hard palate and as far back as the uvula. These variations are divided into front, central, or back velars in parallel with the vowel space (Ladefoged and Maddieson (1996)). They are hard to distinguish phonetically from palatal consonants, though they are produced slightly behind the area of prototypical palatal consonants (Keating and Lahiri (1993)).
5. Properties of the Uvular Consonants: Uvular consonants are made by the tongue body approaching or contacting the uvula. They are rare, occurring in an estimated 19 percent of world's languages, and large regions of America and Africa have no language with uvular

consonants. In languages with uvular consonants, stops are most frequent followed by continuants, including nasals (Maddieson (2013)).

Pharyngeal and Laryngeal

1. Definition of Laryngeal/Pharyngeal Consonants: Consonants made by the constriction of the throat are pharyngeal, and those that are made by a constriction in the throat are laryngeal. Laryngeals are made using the vocal folds as the larynx is far too down the throat to reach the tongue. Pharyngeals, however, are close enough to the mouth that parts of the tongue can reach them.
2. Consonants of the Radical Category: Radical consonants either use the root of the tongue or the epiglottis during production and are produced very far back in the vocal tract (Ladefoged and Maddieson (1996)).
3. Pharyngeal Consonants - Production and Properties: Pharyngeal consonants are produced by retracting the root of the tongue far enough to almost touch the wall of the pharynx. Due to production difficulties only fricatives and approximants are produced this way (Ladefoged and Maddieson (1996), Lodge (2009)).
4. Epiglottal Consonants - Production and Types: Epiglottal consonants are made with the epiglottis and the back wall of the pharynx. Epiglottal consonants have been recorded in Dahalo (Ladefoged and Maddieson (1996)). Voiced epiglottal consonants are not deemed possible due to the cavity between the epiglottis and the glottis being too small to permit voicing (Ladefoged and Maddieson (1996)).
5. Glottal Consonants Production and Constraints: Glottal consonants are those produced using the vocal folds in the larynx. Because the vocal folds are the source of phonation and are below the oral-nasal vocal tract, a number of glottal consonants, such as a voice glottal stop, are impossible.

6. Types of Glottal Consonants Possible: Three glottal stops are possible – a voiceless glottal stop and two glottal fricatives, and all are attested in natural languages (International Phonetic Association (2015)).
7. Production and Purpose of Glottal Stops: Glottal stops, produced by closing the vocal folds, are notably common in world's languages (Ladefoged and Maddieson (1996)). While many languages use them to demarcate phrase boundaries, some languages such as Huatla Mazatec have them as contrastive phonemes.
8. Ways of Realizing Glottal Stops: Additionally, glottal stops can be realized as laryngealization of the following vowel in a language (Ladefoged and Maddieson (1996)). Glottal stops, especially between vowels, do not usually form a complete closure. True glottal stops normally occur only when they are geminated (Ladefoged and Maddieson (1996)).

The Larynx

1. Larynx and Vocal Folds/Cords: The larynx, commonly known as the "voice box", is a cartilaginous structure in the trachea responsible for phonation. The vocal folds/cords are held together so that they vibrate, or held apart so that they do not.
2. Vocal folds Position and Tension: The positions of the vocal folds are achieved by the movement of the arytenoid cartilages (Ladefoged and Johnson (2011)). The intrinsic laryngeal muscles are responsible for moving the arytenoid cartilages as well as modulating the tension of the vocal folds (Seikel, Drumright, and King (2016)).
3. Separation of the Vocal Folds: If the vocal folds are not close or tense enough, they will vibrate sporadically or not at all. If they vibrate sporadically it will result in creaky or breathy voice, depending on the degree; if they don't vibrate at all, the result will be voicelessness.
4. Pressure Differential for an Airflow: In addition to correctly positioning the vocal folds, there must be air flowing across them or they will not vibrate. The difference in pressure across the glottis required for voicing is estimated at $1 - 2\ cm\ H_2O - 98.0665 - 196.033\ Pascals$

(Ohala (1997)). The pressure differential can fall below the levels required for phonation either because of an increase in pressure above the glottis – super-glottal pressure – or a decrease in pressure below the glottis – subglottal pressure.

5. Control of the Subglottal Pressure: The sub-glottal pressure is maintained by the respiratory muscles.
6. Control of the Supra-glottal Pressure: Supra-glottal pressure, with no restrictions or articulations, is equal to the atmospheric pressure. However, because articulations – especially consonants – represent constrictions of the airflow, the pressure in the cavity behind those constrictions can increase resulting in a higher supra-glottal pressure (Chomsky and Halle (1968)).

Lexical Access

1. Two-stage Theory of Lexical Access: According to the lexical access model, two different stages of cognition are employed; thus, this concept is known as the two-stage theory of lexical access.
2. First Stage - Lexical Selection: The first stage, lexical selection, provides information about the lexical items required to construct the functional level representation. These items are retrieved according to their specific semantic and syntactic properties, but phonological forms are not yet made available at this stage.
3. Second Stage - Retrieval of Wordforms: The second stage, retrieval of wordforms, provides information required for building position level representation (Altmann (2002)).

Articulatory Models

1. Coordinate System Basis for Articulation: When producing speech, articulators move through and contact particular locations in space resulting in changes to the acoustic signal. Some models of speech production take this as a basis for modeling articulation in a coordinate system that may be internal to the body, i.e., intrinsic, or external, i.e., extrinsic.
2. Conception behind Intrinsic Coordinate System: Intrinsic coordinate systems model the movements of the articulators as positions and angles of joints in the body. Intrinsic coordinate models of the jaw often use two to three degrees of freedom, representing translation and rotation.
3. Drawbacks of the Intrinsic Coordinate Systems: These face issues modeling the tongue, which, unlike joints of jaw or arms, is a muscular hydrostat, like an elephant trunk, which lacks joins (Lofqvist (2010)). Because of the different physiological structures, movement paths of the jaw are relatively straight lines during speech and mastication, while movement of the tongue follow curves (Munhall, Ostry, and Flanagan (1991)).
4. Rationale behind Extrinsic Coordinate Systems: Straight-line movements have been used to argue articulations as planned in extrinsic rather than intrinsic space, though extrinsic coordinate systems also include acoustic coordinate spaces, not just physical coordinate spaces (Lofqvist (2010)).
5. Extrinsic Coordinate Space – Inverse Problem: Movements that assume that movements are planned in an extrinsic space run into an inverse problem of explaining the muscle and joint locations which produce the observed path or acoustic signal. The arm, for example, has 7 degrees of freedom and 22 muscles, so multiple different joint and muscle configurations can lead to the same final position.
6. Non-unique Muscle Movement Mappings: For models of planning in acoustic space, the same one-to-many problem applies as well, with no unique mappings from the physical or the acoustic targets to the muscle movements required to achieve them. Concerns about the inverse problem may be exaggerated, however, as speech is a highly learned skill using neurological structures that evolved for the purpose (Lofqvist (2010)).
7. The Target Equilibrium-Point Model: The equilibrium-point model proposes a resolution to the inverse problem by arguing that movement targets can be represented as the position of the muscle mass pairs acting on a joint (Feldman (1966)). Importantly, muscles are modeled as springs, and the target is the equilibrium point for the modeled spring-mass system.

8. Advantages of the Equilibrium-Point Model: By using springs, the equilibrium-point model can easily account for compensation and response when movements are disrupted. They are considered a coordinate model because they assume that these muscle positions are represented as points in space – equilibrium points – where the spring-like action of the muscles converges (Bizzi, Hogan, Mussa-Ivaldi, and Giszter (1992), Lofqvist (2010)).
9. The *Minimal Unit* Gestural Model: Gestural approaches to speech production propose that articulations be represented as movement patterns rather than particular coordinates to hit. The minimal unit is a gesture that represent a group of "fundamentally equivalent articulatory movement patterns that are actively controlled with reference to a given speech-relevant goal, e.g., a bilabial closure" (Salzman and Munhall (1989)).
10. Task-Specific Groupings of Muscles: These groups represent coordinated structures or synergies which view movements not as individual muscle movements but as task-dependent groupings of muscle which work together as a single unit (Mattingly (1990), Lofqvist (2010)).
11. Reduction in Degrees of Freedom: This reduces the degrees of freedom in articulation planning, a problem especially in intrinsic coordinate models, which allows for any movement that achieves the speech goal, rather than encoding the particular movements in the abstract representation.
12. Coarticulations under the Gestural Model: Coarticulation is well-described by gestural models, as articulations at faster speech rates can be explained as composites of independent gestures at slower speech rates (Lofqvist (2010)).

Acoustics

1. Importance of Place/Manner of Articulation: Speech sounds are created by the modification of the airstream which results in a sound wave. The modification is done by articulators with different places and manners of articulation producing different acoustic results. Since it is

not just the vocal tract but also the position of the tongue that can affect the resulting sound, manner of articulation is important for describing the speech sound.

2. English Example: *Tack* vs *Sack*: The words *tack* and *sack* both begin with the alveolar sounds in English, but differ in how far the tongue is from the alveolar ridge. This difference has a large effect on the airstream and therefore the sound that is produced. Similarly, the direction and the source of the airstream can affect the sound.

Voicing and Phonation Types

1. Speech Sounds – Voiced vs. Voiceless: A major distinction between speech sounds is whether they are voiced. Sounds are voiced when then vocal folds begin to vibrate in the process of phonation.
2. Speech Sounds with/without Phonation: Many sounds can be produced with or without phonation, though physical constraints make phonation difficult or impossible for some articulations.
3. Sound Source for Voiced Articulations: When articulations are voiced, the main source of noise is the periodic vibration of the vocal folds.
4. Other Non-phonation Acoustic Sources: Articulations by voiceless plosives have no acoustic source and are noticeable by their silence, but other voiceless sounds like fricatives create their own acoustic source regardless of phonation.
5. Acoustics of the Phonation Sources: Phonation is controlled by the muscles of the larynx, and languages make use of more acoustic detail than binary voicing. During phonation, the vocal folds vibrate at a certain rate. This vibration results in a periodic waveform that comprises the fundamental frequency and its harmonics.
6. Control of Fundamental Phonation Frequency: The fundamental frequency of the acoustic wave can be controlled by adjusting the muscles of the larynx, and listeners perceive this fundamental frequency as the pitch.

7. Pitch Manipulation in Language Communication: Tonal languages use pitch manipulation to convey lexical information, and many languages use pitch to mark prosodic or pragmatic information.
8. Determinants of the Vocal Fold Vibration: For vocal folds to vibrate, they must be in proper position and there must be air flowing through the glottis (Ohala (1997)).
9. Glottal States for Phonation Ranges: Phonation types are modeled on a continuum of glottal states from completely open, i.e., voiceless, to completely closed, i.e., glottal stop. The optimal position for vibration, and the phonation type most used in speech, the modal voice, exists in the middle of these two extremes.
10. Causes of Breathy/Creaky Voice: If the glottis is slightly wider, breathy voice occurs, while bringing the folds closer together results in creaky voice (Gordon and Ladefoged (2001)).
11. Characteristics of Typical Speech - Modal Voice: The normal phonation pattern used in typical speech is the modal voice, where the vocal folds are held close together with moderate tension. The vocal folds vibrate as a single unit periodically and efficiently with a full glottal closure and no aspiration (Gobl and Ni Chisaide (2010)).
12. Voiceless Phones and Glottal Stop: If the vocal folds are pulled farther apart, they do not vibrate and so produce voiceless phones. If they are held firmly together, they produce a glottal stop (Gordon and Ladefoged (2001)).
13. Production of Breathy/Whispery Voices: If the vocal folds are held slightly further apart than in modal voicing, they produce phonation types like breathy voice – or murmur – and whispery voice. The tension across the vocal ligaments – the vocal chords – is less than modal voicing allowing for air to flow more freely.
14. Characteristics of Breathy/Whispery Voices: Both breathy voice and whispery voice exist on a continuum loosely characterized as going from the more periodic waveform of the breathy voice to the more noisy waveform of the whispery voice. Acoustically, both tend to dampen the first formant with the whispery voice showing more extreme deviations (Gobl and Ni Chisaide (2010)).
15. Production of Creaky Voice: Holding the vocal folds more tightly together results in a creaky voice. The tension across the vocal folds is less than in modal voice, but they are held together tightly resulting in only the ligaments of vocal folds vibrating. The pulses are highly irregular, with low pitch and frequency amplitude (Gobl and Ni Chisaide (2010)).

16. Voicing/Voicing Distinction across World's Languages: Some languages do not maintain a voicing distinction for some consonants – Hawaiian, for example, does not contrast voiced and voiceless plosives – but all languages use voicing to some degree.
17. Phonemic Voicing Contrast for Vowels: For example, no language is known to have phonemic contrast for vowels – exceptions are languages like Japanese, where vowels are produced as voiceless in certain contexts.
18. Phonemic Contrast across Glottal Positions: Other positions of the glottis, such as breathy and creaky voice, are used in a number of languages, like Jalapa Mazatec, to contrast phonemes while in other languages, such as English, they exist allophonically.
19. Identification of Voicing in Segments: There are several ways to determine if a segment is voiced or not, the simplest being to feel the larynx during the speech and note when vibrations are felt. More precise measurements can be obtained through acoustic analysis of a spectrogram or a spectral slice.
20. Spectrographic Analysis of Voiced Segments: In spectrographic analysis, voiced segments show a voicing bar, a region of high acoustic energy, in the low frequencies of voice segments (Dawson and Phelan (2016)).
21. Uncovering Signals of Spectral Slice: In examining a spectral splice, i.e., the acoustic spectrum at a given point in time, the model of the vowel pronounced reverses the filtering of the mouth producing the spectrum of the glottis. A computational model of the unfiltered glottal signal is then fitted to the inverse filtered acoustic signal to determine the characteristics of the glottis (Gobl and Ni Chisaide (2010)).
22. Visual Analysis using Special Instruments: Visual analysis is also available using specialized medical equipment such as ultrasound and endoscopy (Dawson and Phelan (2016)).

Vowels

1. Vowel Production – Unrestricted Vocal Tract: Vowels are broadly characterized by the area of the mouth in which they are produced, but because they are produced without a

constriction in the vocal tract, their precise description relies in measuring acoustic correlates of the tongue position.

2. Cavity Resonance Impacted by Tongue Position: The location of the tongue during vowel production changes the frequency at which the cavity resonates, and it is these resonances – known as formants – which are measured and used to characterize vowels.
3. Definition of the Vowel Height: Vowel height traditionally refers to the highest point of the tongue during articulation (Ladefoged and Maddieson (1996)).
4. Classification of the Height Parameter: The height parameter is divided into four primary levels – high/close, close-mid, open-mid, and low/open. Vowels whose height are in the middle are referred to as mid.
5. Opened-Close/Closed-Open Vowels: Slightly opened-close vowels and slightly closed-open vowels are referred to as near-close and near-open vowels, respectively. The lowest vowels are not articulated with a lowered tongue, but also by lowering the jaw (Lodge (2009)).
6. IPA Vowels:

	Front	**Central**	**Back**
Close			
Near-close			
Close-mid			
Mid			
Open-mid			
Near-open			
Open			

7. Superfluousness of the 7 IPA Vowels: While the IPA implies that there are 7 levels of vowel height, it is unlikely that a given language can minimally contrast all 7 levels. Chomsky and Halle (1968) suggest that there are only three levels, although four levels of vowel height

seem to be needed to describe Danish and it is possible that some languages may even need five (Ladefoged and Maddieson (1996)).

8. Classification of the Backness Parameter: Vowel backness is divided into three levels: front, central, and back. Languages usually do not contrast more than two levels of vowel backness. Languages claimed to have a three-way backness distinction include Nimboran and Norwegian (Ladefoged and Maddieson (1996)).
9. Characteristics of the Lip Position: In most languages, the lip position during vowel production can be classified as either rounded or unrounded/spread, although other types of lip positions, such as compression and protrusion, have been described.
10. Lip Position/Height/Backness Correlation: Lip position is correlated with height and backness: front and low vowels tend to be rounded whereas back and high vowels are usually unrounded (Ladefoged and Maddieson (1996)). Paired vowels on the IPA chart have the spread vowel on the left and the rounded vowel on the right (Lodge (2009)).
11. Additional Generic Vowel Characterization Features: Together with the universal vowel features described above, some languages have additional features such as nasality, length, and different types of phonation such as voiceless and creaky.
12. Specialized Tongue Gesture Descriptor Parameters: Sometimes more specialized tongue gestures, such as rhoticity, advanced tongue root, pharyngealization, stridency, and frication are required to describe a certain vowel (Ladefoged and Maddieson (1996)).

Manner of Articulation

1. Articulator Modification of Vocal Tract: Knowing the place of articulation is not enough to fully describe a consonant, the way in which the stricture happens is equally important. Manner of articulation describes exactly how the articulator modifies, narrows, or closes off the vocal tract (Ladefoged and Maddieson (1996)).
2. Manner of Articulation for Plosives: Stops – also referred to as plosives – are consonants where the airstream is completely obstructed. Pressure builds up in the mouth during the

stricture, which is then released as a small burst of sound when the articulators move apart. The velum is raised so that the air cannot flow through the nasal cavity.

3. Production of a Nasal Stop: If the velum is lowered and allows for air to flow through the nose, the result is a nasal stop. However, phoneticians always refer to nasal stops as just *nasals* (Ladefoged and Maddieson (1996), Ladefoged and Johnson (2011)).
4. Manner of Articulation for Fricatives: Fricatives are consonants where the airstream is made turbulent by partially, but not completely, obstructing part of the vocal tract. Sibilants are special type of fricatives where the turbulent airstream is directed towards the teeth (Ladefoged and Maddieson (1996)), creating a high-pitched hissing sound (Ladefoged and Johnson (2011)).
5. Manner of Articulation for Affricates: Affricates are a sequence of steps followed by a fricative in the same place (Ladefoged and Johnson (2011)).
6. Manner of Articulation for Approximants: In an approximant, the articulators come close together, but not to such an extent that allows a turbulent airstream (Ladefoged and Johnson (2011)).
7. Manner of Articulation for Laterals: Laterals are consonants in which the airstream is obstructed along the center of the vocal tract, allowing the airstream to flow freely on one or both sides (Ladefoged and Johnson (2011)). Laterals are also defined as consonants in which the tongue is contracted in such a way that the airstream is greater around the sides than over the center of the tongue (Ladefoged and Maddieson (1996)).
8. Manner of Articulation for Trills: Trills are consonants in which the tongue or the lips are set in motion by the airstream (Ladefoged and Johnson (2011)). The stricture is formed in such a way that the airstream causes a repeating pattern of opening and closing of the soft articulator(s) (Ladefoged and Maddieson (1996)). Apical trills typically consist of two or three periods of vibration.
9. Taps/Flaps Manner of Articulation: Taps and flaps are single, rapid, usually apical gestures where the tongue is thrown against the roof of the mouth, comparable to a very rapid stop (Ladefoged and Johnson (2011)). These terms are sometimes used interchangeably, but some phoneticians make a distinction (Ladefoged and Maddieson (1996)). In a tap, the tongue contacts the roof in a single motion, whereas in a flap the tongue moves tangentially to the roof of the mouth, striking it in passing.

10. Mechanism behind Glottalic Airstream Articulation: During a glottalic airstream mechanism, the glottis is closed, trapping a body of air. This allows for the remaining air in the vocl tract to be moved separately.
11. Ejective/Implosive Manner of Articulation: An upward movement of the glottis will move the air out, resulting in an ejective consonant. Alternatively, the glottis can lower, sucking air into the mouth, which results in an implosive consonant (Ladefoged and Johnson (2011)).
12. Clicks/Velaric Airstream Articulation Mechanism: Clicks are stops in which the tongue movement causes the airstream to be sucked in the mouth, this is referred to as a velaric airstream (Ladefoged and Maddieson (1996)). During the click the air becomes rarefied between two articulatory closures, producing a loud *click* sound when the anterior is released.
13. Influx and Efflux Click Consonants: The release of the anterior closure is referred to as the click influx. The release of the posterior closure, which can be velar or uvular, is the click efflux.
14. Click Usage in African Languages: Clicks are used in several African language families, such as Khoisan and Bantu languages (Ladefoged and Maddieson (1996)).

Pulmonary and Subglottal System

1. Lung Pressure and Pulmonic Egress: The lungs drive nearly all speech production, and their importance in phonetics is due to their creation od pressure in pulmonic sounds. The most common kind of sounds is the pulmonic egress, where air is exhaled from the lings (Ladefoged and Johnson (2011)).
2. Pulmonic Ingress and its Occurrence: The opposite is possible, although no language is known to have pulmonic ingressive sounds as phonemes. Many languages such as Swedish use them for paralinguistic articulations such as affirmations, though this is the case in a number of geographically diverse languages (Eklund (2008)).

3. Pulmonic Air Draw vs Vital Capacity: Both ingressive and egressive sounds rely on holding the vocal folds at a particular posture and using the lungs to draw the air across the vocal folds so that they either vibrate – voiced – or do not vibrate – voiceless (Ladefoged and Johnson (2011)). Pulmonic articulations are restricted by the volume of air exhaled in a given respiratory cycle, known as the vital capacity.
4. Maintenance of Super/Sub Glottal Pressure: The lungs are used to maintain two kinds of pressure in order to produce and modify phonation. To produce phonation at all, the lings must maintain a pressure of $3 - 5\ cm\ H_2O$ higher than the pressure above the glottis.
5. Pressure Differential for Suprasegmentals: However, small and fast adjustment are made to the subglottal pressure to modify speech for suprasegmental features like stress. A number of thoracic muscles are used to make these adjustments.
6. Vital Capacity Pressure Differential Retention: Because the lungs and the thorax stretch during inhalation, the elastic forces of the lungs alone can produce differentials for lung volumes above 50 percent of the vital capacity (Seikel, Drumright, and King (2016)).
7. Vital Capacity Pressure Maintenance Mechanism: Above 50 percent of the vital capacity, the respiratory muscles are used to "check" the elastic forces of the thorax to maintain a stable pressure differential. Below that volume, they are used to increase the sub-glottal pressure by actively exhaling air.
8. Accommodating Linguistic and Metabolic Needs: During speech, the respiratory is modified to accommodate both the linguistic and the biological needs. Exhalation, usually about 60 percent of the respiratory cycle at rest, is increased to about 90 percent of the respiratory cycle. Because metabolic needs are relatively stable, the total air moved in most cases of speech remain about the same as quiet tidal breathing (Seikel, Drumright, and King (2016)).
9. Age/Loudness Vital Capacity Impact: Increase in speech intensity of 18 dB – a loud conversation – has relatively little impact on the volume of air moved. Because their respiratory systems are not as developed as adults, children tend to use a larger proportion of their vital capacity compared to adults, with more deeper inhales (Seikel, Drumright, and King (2016)).

Source-Filter Theory

1. Source-Filter Model of Speech: The source-filter model of speech is a theory of speech production which explains the link between vocal tract posture and acoustic consequences (Johnson (2011)). The noise source in many cases is the larynx during the process of voicing, though other noise sources can be modeled the same way.
2. Factors Impacting the Generated Acoustic Patterns: The shape of the supraglottal vocal tract as the filter, and different configurations of the articulators result in different acoustic patterns. The changes are predictable.
3. Acoustics of Vocal Tract Modeling: The vocal tract can be modeled as a sequence of tunes, closed at one end, with varying diameters, and by using equations for acoustic resonance, the acoustic effect of an articulatory posture can be derived (Johnson (2011)).
4. Acoustics Produced by the Vocal Folds: The process of inverse filtering uses this principle to analyze the source spectrum produced by the vocal folds during the voicing. By taking the inverse of the predicted filter, the acoustic effects of the supraglottal vocal tract can be undone giving the acoustic spectrum produced by the vocal folds (Johnson (2011)). This allows for the quantitative study of various phonation types.

Perception

1. Language Perception – Decoding Linguistic Signal: Language perception is the process by which the linguistic signal is decoded and understood by the listener.
2. Decomposition into Phonemes/Morphemes/Words: In order to perceive speech, the continuous acoustic signal must be converted into discrete linguistic units such as phonemes, morphemes, and words (Sedivy (2019)).
3. Prioritization/Enhancement of Acoustic Cues: In order to correctly identify and categorize sounds, listeners prioritize certain aspects of the signal that can reliably distinguish between

linguistic categories. While certain cues can be prioritized over others, many aspects of the signal can contribute to the perception. For example, though oral languages prioritize acoustic information, the McGurk effect shows that the visual information is used to distinguish ambiguous information where acoustic cues are unreliable (Sedivy (2019)).

4. <u>Acoustic Signal/Category Perception Mapping</u>: While listeners can use a variety of information to segment speech signal, the relationship between acoustic signal and category perception is not a perfect mapping. Because of coarticulation, noisy environment, and individual differences, there is a high degree of acoustic variability within categories (Sedivy (2019)).
5. <u>Perceptual Invariance - Definition and Motivation</u>: Known as the problem of *perceptual invariance*, listeners are able to reliably perceive categories despite the variability in acoustic information. In order to accommodate this, listeners rapidly accommodate new speakers and will shift their boundaries between the categories to match the acoustic distinctions their conversational partner is making (Sedivy (2019)).

Perception – Audition

1. <u>Air Pressure to Sound Transform</u>: Audition, the process of hearing sounds, is the first stage of perceiving speech. Articulators cause systematic change in air pressure which travel as sound waves to the listener's ears.
2. <u>Ear Drum to Cochlear Bones</u>: The sound waves then hit the listener's eardrum causing it to vibrate. The vibration of the eardrum is transmitted by the ossicles – three small bones of the middle ear – to the cochlea (Johnson (2003)).
3. <u>Tonotopic Design of Basilar Membrane</u>: The cochlea is a spiral-shaped, fluid-filled tube divided lengthwise by the organ of Corti which contains the basilar membrane. The basilar membrane increases in thickness as it travels through the cochlea causing different

frequencies to resonate at different locations. This tonotopic design allows for the ear to analyze sound in a manner similar to a Fourier transform (Johnson (2003)).

4. Acoustic to Neuronal Signal Conversion: The differential vibration of the basilar causes the hair cells within the organ of Corti to move. This cases depolarization of the hair cell and ultimately a conversion of the acoustic signal into a neuronal signal (Schachter, Gilbert, and Wegner (2011)).
5. Production of the Action Potentials: While the hair cells do not produce action potentials themselves, they release neurotransmitter at synapses with the fibers of the auditory nerve, which does produce action potentials. In this way, patterns of oscillations on the basilar membrane are converted to spatiotemporal firings which transmit information about the sound to the brainstem (Yost (2003)).

Prosody

1. Cross-Speech Auditory Properties/Degrees: Besides consonants and vowels, phonetics also describes properties of speech that are localized to segments but to greater units of speech such as syllables and phrases. Prosody includes auditory characteristics such as pitch, speech rate, duration, and loudness.
2. Prosody Property Correlates across Languages: Languages use these properties in different degrees to implement stress, pitch accents, and intonation – for example, stress in English and Spanish is correlated with changes in pitch and duration, whereas stress in Welsh is more consistently corelated with pitch than duration, and stress is Thai is only correlated with duration (Cutler (2005)).

Theories of Speech Perception

1. Motivation behind the Motor Theory: Early theories of speech perception such as the motor theory attempted to solve the problem of perceptual invariance by arguing that speech production and perception are closely linked.
2. Strong Form of Motor Theory: In its strongest form, motor theory argues that speech perception requires the listener to access the articulatory representation of sound (Sedivy (2019)); in order to properly categorize a sound, a listener reverse engineers the articulation which would produce the sound and by identifying the gestures is able to retrieve the linguistic category (Galantucci, Fowler, and Turvey (2006)).
3. Weak Form of Motor Theory: While findings such as the McGurk effect and case studies from patients with neurological injuries have provided support for the motor theory, further experiments have not supported the string form of the motor theory, though there is some support for weaker forms of motor theory which claim a non-deterministic relationship between production and perception (Galantucci, Fowler, and Turvey (2006), Skipper, Devlin, and Lametti (2017), Sedivy (2019)).
4. Successor Theories of Speech Perception: Successor theories of speech perception place the focus on acoustic cues to sound categories and can be grouped into two broad categories: abstractionist theories and episodic theories (Goldinger (1996)).
5. Idea behind the Abstractionist Theories: In abstractionist theories, speech perception involves the identification of an idealized lexical object based on a signal reduced to its necessary components and normalizing the signal to counteract speaker variability.
6. Motivation behind the Episodic Thesis: Episodic theories such as the exemplar model argue that speech perception involves accessing detailed memories, i.e., episodic memories, of previously heard tokens. The problem of perceptual invariance is explained by the episodic theories as an issue of familiarity; normalization is a by-product of exposure to more variable distributions rather than a discrete process as abstractionist theories claim (Goldinger (1996)).

Sub-disciplines – Acoustic Phonetics

Acoustic phonetics deals with the acoustic properties of speech sounds. The sensation of sound is caused by pressure fluctuations which cause the eardrum to move. The ear transforms this movement into neuronal signals that the brain registers as sound. Acoustic waveforms are records that measure these pressure fluctuations (Johnson (2011)).

Sub-discipline – Articulatory Phonetics

Articulatory phonetics deals with the ways in which speech sounds are made.

Sub-disciplines – Auditory Phonetics

1. Transforming Acoustics for Human Perception: Auditory phonetics studies show how human perceive speech sounds. Due to the fact that the anatomy of the auditory system distorts the speech signals, humans do not experience speech sounds as perfect acoustic records. For example, the auditory impressions of volume, measured in decibels dB, do not linearly match the difference in sound pressure (Johnson (2011)).
2. Acoustics vs. Listener Mismatch Characterization: The mismatch between acoustic analysis and what the listener hears is especially noticeable in speech sounds that have a lot of high-

frequency energy, such as certain fricatives. To reconcile this mismatch, functional models of auditory system have been developed (Johnson (2011)).

Describing Sounds

1. Ways of Specifying Speech Phones: Human languages use many different sounds and in order to compare them linguists must be able to describe sounds in a way that is language independent. Speech sounds can be described in a number of different ways.
2. Gross Categorization - Consonants and Vowels: Most commonly, speech sounds are referred to by the mouth movements needed to produce them. Consonants and vowels are two categories that phoneticians define by the movements in a speech sound. More fine-grained descriptors are parameters such as place of articulation.
3. Fine-grained Consonant/Vowel Chart: Place of articulation, manner of articulation, and voicing are used to describe consonants and are the main divisions of the International Phonetic Alphabet consonant chart. Vowels are described by their height, backness, and rounding.
4. Sign Language Specification Parameters: Sign language I described by a similar but a distinct set of parameters to describe signs: location, movement, hand-shape, palm-orientation, and non-manual features.
5. Describing Sounds in Oral Languages: In addition to articulatory descriptions, sounds in oral languages can be described using their acoustics. Because the acoustics are a consequence of the articulation, both methods of description are sufficient to distinguish sounds with the choice between the systems dependent on the phonetics being investigated.
6. Consonants - Obstruction of the Vocal Tract: Consonants are speech sounds that are articulated with a complete or a partial closure of the vocal tract. They are generally produced by a modification of the airstream exhaled from the lungs.

7. Respiratory Organs Manipulating the Airflow: The respiratory organs used to create and modify the airflow are divided into three regions: the vocal tract – supra-laryngeal, the larynx, and the subglottal system. The airstream can either be egressive – out of the vocal tract, or ingressive – into the vocal tract.
8. Pulmonic, Glottalic, and Click Consonants: In pulmonic, the airstream is produced by the lungs in the sub-glottal system and passes through the larynx and the vocal tract. Glottalic sounds use an airstream created by the movements of the larynx without airflow from the lungs. Click consonants are articulated through the rarefaction of the air using the tongue, followed by the release of the forward closure of the tongue.
9. Vowels - No Vocal Tract Obstruction: Vowels are syllabic speech sounds which are pronounced without any obstruction in the vocal tract (Ladefoged and Maddieson (1996)). Unlike consonants, which usually have definite places of articulation, vowels are defined in relation to a set of reference vowels called cardinal vowels. Three properties are needed to define vowels: tongue height, tongue backness, and lip roundedness.
10. Distinction between Monophthongs and Diphthongs: Vowels that are articulated with a stable quality are called monophthongs; a combination of two separate vowels in the same syllable is a diphthong (Gussenhoven and Jacobs (2017)).
11. IPA Chart Vowel Representation Scheme: In the IPA, the vowels are represented on a trapezoid shape representing the human mouth; the vertical axis represents the mouth from floor to roof and the horizontal axis represents the front-back dimension (Lodge (2009)).

Transcription

1. IPA Symbols for Oral Phones: Phonetic transcription is a system for transcribing phones that occur in a language, whether oral or sign. The most widely known system of phonetic transcription – the International Phonetic Alphabet IPA – provides a standardized set of symbols for oral phones (International Phonetic Association (1999), O’Grady (2005)).

2. <u>Purpose and Usage of IPA</u>: The standardized nature of the IPA enables its users to transcribe accurately and consistently the phones of several languages, dialects, and idiolects (Ladefoged and Maddieson (1996), International Phonetic Association (1999), O'Grady (2005)). The IPA is a useful tool not only for the study of phonetics, but also for language teaching, professional acting, and speech pathology (Ladefoged and Johnson (2011)).
3. <u>Standardized Symbols for Sign Languages</u>: While no sign language has a standardized writing system, linguists have developed their own notation systems that describes handshape, location, and movement. The Hamburg Notation System – HamNoSys – is similar to IPA in that it allows varying levels of detail.
4. <u>Comparing HamNoSys, KOMVA, and Stokoe</u>: Some notations such as KOMVA and the Stokoe system were designed for use in dictionaries; they also make use of alphabetic letters in the local language for handshapes whereas HamNoSys represents handshapes directly.
5. <u>SignWriting Easy-to-Learn Language</u>: SignWriting aims to be an easy-to-learn writing system for sign languages, although it has not been officially adopted by any deaf community yet (Baker, van den Bogaerde, Pfau, and Schermer (2016)).

Sign Languages

1. <u>Visual Perception of Sign Languages</u>: Unlike spoken languages, words in sign languages are perceived with the eyes instead of the ears. Signs are articulated with hands, upper body, and head. The main articulators are the hands and the arms.
2. <u>Proximal and Distal Sign Movements</u>: Relative parts of the arm are described with the terms proximal and distal. Proximal refers to a part closer to the torso whereas a distal part is further away from it. For example, a wrist movement is distal compared to an elbow movement. Due to requiring less energy, distal movements are easier to produce.

3. Criteria Restricting Formation of Sign: Various factors – such as muscle flexibility or being considered taboo – restricted what can be considered a sign (Baker, van den Bogaerde, Pfau, and Schermer (2016)).
4. Signs Articulated Close to Face: Native signers do not look at their conversation partner's hands. Instead, their gaze is fixated on the face. Because peripheral vision is not as focused as the center of the visual field, signs articulated near the face allow for more subtle differences in finger movements and articulation to be perceived (Baker, van den Bogaerde, Pfau, and Schermer (2016)).
5. Signs Produced with Two Hands: Unlike spoken languages, sign languages have two identical articulators – the hands. Signers may use whichever hand they prefer with no disruption in communication.
6. First Universal Constraint - Symmetry Condition: Due to universal neurological limitations, two-handed signs generally have the same kind of articulation in both hands; this is referred to as the Symmetry Condition (Baker, van den Bogaerde, Pfau, and Schermer (2016)).
7. Second Universal Constraint - Dominance Condition: The second universal constraint I the Dominance Condition, which holds that when two handshapes are involved, one hand will remain stationary and have a more limited set of handshapes compared to the dominant, moving hand (Baker, van den Bogaerde, Pfau, and Schermer (2016)).
8. Sign Influenced Coarticulation - Assimilation/Deletion: Additionally, it is common for one hand in a two-handed sign to be dropped during informal conversations, a process referred to as weak drop (Baker, van den Bogaerde, Pfau, and Schermer (2016)). Just like words in spoken languages, coarticulation may cause signs to influence each other's form. Examples include handshape of neighboring signs becoming similar to each other, i.e., assimilation, or weak drop, i.e., an instance of deletion.

References

- Altmann, G. (2002): *Psycholinguistics: Critical Concepts in Psychology* **Routledge** London, UK
- Baker, A., B. van den Bogaerde, R. Pfau, and T. Schermer (2016): *The Linguistics of Sign Languages* **John Benjamins Publishing Company** Amsterdam, Netherlands
- Bizzi, E., N. Hogan, F. Mussa-Ivaldi, and S. Giszter (1992): Does the Nervous System use Equilibrium-Point Control to Guide Single and Multiple Joint Movements? *Behavioral and Brain Sciences* **15 (4)** 603-613
- Boersma, P. (1998): *Functional Phonology: Formalizing the Interactions between Articulatory and Perceptual Drives* **Holland Academy Graphics** The Hague
- Chomsky, N., and M. Halle (1968): *Sound Pattern of English* **Harper and Row**
- Cutler, A. (2005): Lexical Stress, in: *The Handbook of Speech Perception (Editors: Pisoni, D. B., and R. Remez)* **Blackwell**
- Dawson, H., and M. Phelan (2016): *Language Files: Materials for an Introduction to Linguistics 12th Edition* **The Ohio State University Press** Columbus, OH
- Dell, G. and P. O'Seaghdha (1992): Stage of the Lexical Access in Language Production *Cognition* **4 (1-3)** 287-314
- Doke, C. M. (1926): *The Phonetics of the Zulu Language* **Witwatersrand University Press** Johannesburg, South Africa
- Eklund, R. (2008): Pulmonic Ingressive Phonation: Diachronic and Synchronic Characteristics, Distribution, and Function in Animal and Human Sound Production and in Human Speech *Journal of the International Phonetic Association* **35 (3)** 235-324
- Feldman, A. G. (1966): Functional Tuning of the Nervous System with Control of Movement or Maintenance of Steady Posture, III: Mechanographic Analysis of the Execution by Man of the Simplest Motor Task *Biophysics* **11** 565-578
- Fujimura, O. (1961): Bilabial Stop and Nasal Consonants: A Motion Picture Study and its Acoustical Implications *Journal of Speech and Hearing Research* **4 (3)** 233-247
- Galantucci, C. Fowler, and M. Turvey (2006): The Motor Theory of Speech Perception Reviewed *Psychonomic Bulletin and Review* **13 (3)** 361-377.
- Gleitman, L., D. January, R. Nappa, and J. Trueswell (2007): On the Give and Take between Event Apprehension and Utterance Formulation *Journal of Memory and Language* **57 (4)** 544-569

- Gobl, C., and A. Ni Chisaide (2010): Voice source Variation and its Communicative Functions, in: *The Handbook of Phonetic Sciences 2nd Edition (Editors: Hardcastle, W. J., J. Laver, and F. E. Gibbon)* **Wiley**
- Goldinger, S. (1996): Words and Voices: Episodic Trace Spoken Word Identification and Recognition Memory *Journal of Experimental Psychology: Learning, Memory, and Cognition* **22 (5)** 1166-1183
- Gordon, M., and P. Ladefoged (2001): Phonation Types: A Cross-linguistic Overview *Journal of Phonetics* **29 (4)** 383-406
- Gussenhoven, C., and H. Jacobs (2017): *Understanding Phonology 4th Edition* **Rutledge** New York, NY
- Guthrie, M. (1948): *The Classification of Bantu Languages* **Oxford University Press** London, UK
- International Phonetic Association (1999): *Handbook of the International Phonetic Association* **Cambridge University Press** Cambridge, UK
- International Phonetic Association (2015): *International Phonetic Alphabet* **International Phonetic Association** London, UK
- Jaeger, F., K. Furth, and C. Hilliard (2012): Phonological Overlap affects Lexical Selection During Sentence Production *Journal of Experimental Psychology: Learning, Memory, and Cognition* **38 (5)** 1439-1449
- Johnson, K. (2011): *Acoustic and Auditory Phonetics 3rd Edition* **Wiley-Blackwell**
- Keating, P., and A. Lahiri (1993): Fronted Velars, Palatalized Velars, and Palatals *Phonetic* **50 (2)** 73-101
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Ladefoged, P., and K. Johnson (2011): *A Course in Phonetics 6th Edition* **Wadsworth**
- Lodge, K. (2009): *A Critical Introduction to Phonetics* **Continuum International Publishing Group** New York, NY
- Lofqvist, A. (2010): Theories and Models of Speech Production, in: *The Handbook of Phonetic Sciences 2nd Edition (Editors: Hardcastle, W. J., J. Laver, and F. E. Gibbon)* **Wiley**

- Maddieson, I. (1993): Investigating Ewe Articulations with Electromagnetic Articulography *Forschungberichte des Instituts fur Phonetik und Sprachtliche Kommunikation der Universitat Munchen* **31** 181-214
- Maddieson (2013): Uvular Consonants, in: *The World Atlas of Language Structures Online (editors: Dryer, M. S., and M. Haspelmath)* **Max Planck Institute for Evolutionary Anthropology** Leipzig, Germany
- Mattingly, I. (1990): The Global Character of Phonetic Gestures *Journal of Phonetics* **18 (3)** 445-452
- Motley, M., C. Camden, and B. Baars (1982): Covert Formulation and Editing of Anomalies of Speech Production: Evidence from Experimentally Elicited Slips of the Tongue *Journal of Verbal Learning and Verbal Behavior* **21 (5)** 578-594
- Munhall, K., D. Ostry, and J. Flanagan (1991): Coordinate Spaces in Speech Planning *Journal of Phonetics* **19 (3-4)** 293-307
- O'Grady, W. (2005): *Contemporary Linguistics: An Introduction 5th Edition* **Bedford/St. Martin's**
- Ohala, J. (1997): Aerodynamics of Phonology *Proceedings of the Seoul International Conference on Linguistics* **92**
- Saltzman, E., and K. Munhall (1989): Dynamical Approach to Gestural Patterning in Speech Production *Ecological Psychology* **1 (4)** 333-382
- Scatton, E. (1984): *A Reference Grammar of Modern Bulgarian* **Slavica**
- Schachter, D., D. Gilbert, and D. Wegner (2011): Sensation and Perception, in: *Psychology (Editors: Linsmeiser, C.)* **Worth Publishers**
- Sedivy, J. (2019): *Languages in Mind: An Introduction to Psycholinguistics 2nd Edition* **Oxford University Press**
- Seikel, J. A., D. Drumright, and D. King (2016): *Anatomy and Physiology for Speech, Language, and Hearing 5th Edition* **Cengage**
- Skipper, J., J. Devlin, and D. Lametti (2017): The Hearing Ear is always Close to the Speaking Tongue: Review of the Role of the Motor System in Speech Perception *Brain and Language* **164** 77-105
- Yost, W. (2003): Audition, in: *Handbook of Psychology: Experimental Psychology (Editors: Healy, A. F., and R. W. Proctor)* **John Wiley and Sons**

Acoustic Phonetics

1. Coverage Scope of Acoustic Phonetics: *Acoustic Phonetics* is a subfield of phonetics, which deals with the acoustic aspects of speech sounds. Acoustic phonetics investigates the time domain features such as the mean squared amplitude of a waveform, its duration, its fundamental frequency, or frequency domain features such as the frequency spectrum, or even combined spatiotemporal features and the relationship of these properties to other branches of phonetics, e.g., articulatory or auditory phonetics, and to linguistic concepts such as phonemes, phrases, or utterances (Wikipedia (2021)).
2. ILPR - Approximation of the Voice Signal: Integrated Linear Prediction Residuals – ILPR – was an effective feature proposed which closely approximates the voice source signal (Ananthapadmanabha (1995)). This proved to be very effective in the accurate estimation of the epochs or the glottal closure instant (Prathosh, Ananthapadmanabha, and Ramakrishnan (2013)).
3. Speaker Information Supplementing Voice Signal: Ramakrishnan, Abhiram, and Mahadeva Prasanna (2015) showed that the discrete cosine transform coefficients of the ILPR contains speaker information that supplements the mel frequency cepstral coefficients.
4. Characterizing Stop Consonants - Plosion Index: Plosion index is another scalar, time-domain feature that was introduced by Ananthapadmanabha, Prathosh, and Ramakrishnan (2014) for characterizing closure-burst transition of stop consonants.

References

- Ananthapadmanabha, T. V. (1995): Acoustic Factors determining Perceived Voice Quality, in: *Vocal Fold Physiology – Voice Quality Control (Editors: Fujimura, O., and M. Hirano)* **Singular Publishing Group** San Diego, CA
- Ananthapadmanabha, T. V., A. P. Prathosh, and A. G. Ramakrishnan (2014): Detection of the Closure-burst Transition of Stops and Affricates in Continuous Speech using the Plosion Index *Journal of the Acoustical Society of America* **135 (1)** 460-471
- Prathosh, A. P., T. V. Ananthapadmanabha, and A. G. Ramakrishnan (2013): Epoch Extraction Based on Integrated Linear Prediction Residual using Plosion Index *IEEE Transactions on Audio, Speech, and Language Processing* **21 (12)** 2471-2480
- Ramakrishnan, A. G., B. Abhiram, and S. R. Mahadeva Prasanna (2015): Voice Source Characterization using Pitch Synchronous Discrete Cosine Transform for Speaker Identification *Journal of the Acoustical Society of America* **137 (6)** EL469-475
- Wikipedia (2021): Acoustic Phonetics

Articulatory Phonetics

Overview

1. Focus of Articulatory Phonetics Subfield: The field of *articulatory phonetics* is a subfield of phonetics that studies *articulation* and the way humans produce speech. Articulatory phoneticians explain how humans produce speech sounds via the interaction of different physiological studies. Generally, articulatory phonetics is concerned with the transformation of aerodynamic energy into acoustic energy (Wikipedia (2021)).
2. Aerodynamic Energy off Vocal Tract: Aerodynamic energy refers to the airflow through the vocal tract. Its potential form is air pressure; its kinetic form is the actual dynamic airflow.
3. Pressure Differential Causing Acoustic Energy: Acoustic energy is variation in air pressure that can be represented as sound waves, which are then perceived by the human auditory system as sound. Note that although sound is air pressure variations, the variations must be at a high enough rate to be perceived as sound. If the variation is too low, it will be inaudible.
4. Shaping the Flow of Airstream: Sound is produced by expelling air from the lungs. However, to vary the sound quality in a way useful for speaking, the two speech organs normally move towards each other to contact each other to create an obstruction that shapes the air in a particular fashion.
5. Place vs Manner of Articulation: The point of maximum obstruction is called the *place of articulation*, and the way the obstruction forms and releases is the *manner of articulation*.
6. Example - Pronouncing the Bilabial Plosive: For example, when making the *p* sound, the lips come together tightly, blocking the air momentarily and causing a build-up of the air pressure. The lips then release suddenly causing a burst of sound. The place of articulation of this sound is therefore called *bilabial*, and the manner is called *stop*, also known as a *plosive*.

Components

1. Vocal Tract Components Generating the Sound: The vocal tract can be viewed as an aerodynamic-bio mechanic model that includes three main components:
    a. Air cavities
    b. Pistons
    c. Air Valves
2. Components of the Air Cavity: Air cavities are containers of air molecules of specific volumes and masses. The main air cavities present in the articulatory system are the supraglottal and the subglottal cavities. They are so named because the glottis, the openable space between the vocal folds internal to the larynx, separates the two cavities.
3. Entities in the Supraglottal Cavity: The supraglottal cavity or the orinasal cavity is divided into an oral sub-cavity – the cavity from the glottis to the lips excluding the nasal cavity – and a nasal sub-cavity, the cavity from the velopharyngeal port, which can be closed by raising the velum.
4. Entities in the Subglottal Cavity: The subglottal cavity consists of the trachea and the lungs.
5. The External, Atmospheric Air Cavity: The atmosphere external to the articulatory stem may also be considered an air cavity whose potential connecting points with respect to the body are the nostrils and the lips.
6. Pistons - The Air Pressure Initiators: Pistons are initiators. The term *initiator* refers to the fact that they are used to initiate a change in the volumes of the air cavities, and, by Boyle's Law, the corresponding air pressure of the cavity.
7. Initiation of the Airstream Mechanism: The term *initiation* refers to the change. Since changes in air pressure between connected cavities leads to airflow between the cavities, the initiation is also referred to as an *airstream mechanism*.
8. Pistons of the Articulatory System: The three structures present in the articulatory system are the larynx, the tongue body, and the physiological structures used to manipulate the lung volume – in particular, the floor and the walls of the chest. The lung pistons are used to initiate a pulmonic airstream – this is found in all languages.

9. Initiation of the Glottalic Airstream Mechanism: The larynx is used to initiate the glottalic airstream mechanism by changing the volume of the supraglottal and the subglottal cavities via the vertical movement of the larynx, with a closed glottis. Ejectives and implosives are made via this airstream mechanism.
10. Initiation of the Velaric Airstream Mechanism: The tongue body creates a velaric airstream by changing the pressure within the oral cavity: the tongue body changes the mouth sub-cavity. Click consonants use the velaric airstream mechanism.
11. Control of the Piston Action: Pistons are controlled by various muscles.
12. Valves – Cross-Cavity Airflow Regulator: Valves regulate airflow between cavities. Airflow occurs when an air valve is open and there is a pressure difference between the connecting cavities. When the air valve is closed, there is no airflow.
13. Air Valves of the Articulatory System: The air valves are the vocal folds – the glottis – which regulate between the supra-glottal and the sub-glottal cavities, the velopharyngeal folds which regulate between the oral and the nasal cavities, the tongue which regulates between the oral cavity and the atmosphere, and the lips, which also regulate between the oral cavity and the atmosphere.
14. Control of the Air Valves: Like the pistons, the air valves are also controlled by various muscles.

Initiation

To produce any kind of sound, there must be a movement of air. To produce sounds people can interpret as spoken words, the movement of air must pass through the vocal cords, up through the throat, and into the mouth or the nose to then leave the body. Different sounds are formed by different positions of the mouth – or as linguists call it, *the oral cavity*, to distinguish it from the nasal cavity.

Vowels

1. Airstream Passage during Vowel Production: Vowels are produced by the passage of the air through the larynx and the vocal tract. Most vowels are voiced, i.e., the vocal folds are vibrating.
2. Open Vocal Tract/No Obstruction: Except in some marginal cases, the vocal tract is open, so the airstream is able to escape without generating fricative noise.
3. Control of Vowel Quality Variation: Variation in vowel quality is produced using the articulatory structures described below.

Articulators – Glottis

1. Vibration Produced by the Glottis: The glottis is the opening between the vocal folds located in the larynx. Its position creates different vibration patterns to distinguish voiced and voiceless sounds (Laver (1994)).
2. Pitch Control using Vocal Folds: In addition, the pitch of the vowel is altered by changing the frequency of vibration of the vocal folds. In some languages there are contrasts among vowels with different phonation types (Ladefoged and Maddieson (1996)).

Articulators – Pharynx

1. Pharynx Location and Pharyngealized Vowels: The pharynx is the region of the vocal tract below the velum and above the larynx. Vowels may be pharyngealized – also *epiglottalized*,

sphincteric, and *strident* – by means of a retraction of the tongue root (Ladefoged and Maddieson (1996)).

2. Vowels Produced using ATR Feature: Vowels may be articulated with Advanced Tongue Root ATR (Laver (1994)). There is a discussion as to whether the ATR vowel feature is different from the Tense/Lax distinction in vowels (Ladefoged and Maddieson (1996)).

Velum

1. Nasals Produced by Raising the Velum: The velum – or the soft palate – controls the air flow through the nasal cavity. Nasals and nasalized sounds are produced by lowering the velum and allowing air to escape through the nose.
2. Nasalization in Vowel Production: Vowels are normally with the soft palate raised so that no air escapes through the nose. However, vowels may also be nasalized by lowering the soft palate. Many languages use nasalization constructively (Ladefoged and Maddieson (1996)).

Tongue

1. Tongue Control of Vowel Articulation: The tongue is a highly flexible organ that is capable of being moved in many different ways. For vowel articulation, the principal variations are the vowel height and the dimensions of the backness and the frontness (Ladefoged and Maddieson (1996)).
2. Production of Rhotic/Rhotacized Vowels: A less common variation in vowel quality can be produced by a change in the shape of the front tongue, resulting in a rhotic or a rhotacized vowel (Ladefoged and Maddieson (1996)).

Lips

The lips play a major role in vowel articulation. It is generally believed that two major variables are in effect: lip-rounding or labialization, and lip protrusion.

Airflow

1. Boyle's Law for Articulatory Cavities: For all practical purposes, temperature can be treated as constant in the articulatory system. Thus, Boyle's law can be written as the following two equations:

$$P_1V_1 = P_2V_2$$

$$\frac{V_1}{V_1 + \Delta V} = \frac{P_1 + \Delta P}{P_1}$$

2. Application to the Subglottal Cavity: As applied to the description of the subglottal cavity, when the lung pistons contract the lungs, the volume of the subglottal cavity decreases while the subglottal air pressure increases. Conversely, if the lungs are expanded, the air pressure decreases.
3. Mouth Open + Vocal Folds Closed: A situation can be considered where:
    a. The vocal fold valve is closed separating the supraglottal cavity from the subglottal cavity,

   b. The mouth is open and, therefore, the supraglottal air pressure is equal to the atmospheric pressure, and
   c. The lungs are contracted resulting in a subglottal pressure that has increased to a pressure greater than the atmospheric pressure.
4. <u>Opening the Vocal Cord Valve</u>: If the vocal fold valve is subsequently opened, the previously two separate cavities become one unified cavity although the cavities will still be aerodynamically isolated because the glottalic valve between them is really small and constrictive.
5. <u>Pressure Inequalities over Glottal Cavities</u>: Pascal's Law states that the pressure within a system must equalize throughout the system. When the subglottal pressure is greater than the supraglottal pressure, there is pressure inequality in the unified cavity.
6. <u>Airflow across Cavities until Pressure Equalizes</u>: Since pressure is a force applied to a surface area by definition and a force is the product of mass and acceleration according to Newton's second Law of Motion, the pressure inequality will be resolved by having a part of the mass of air molecules found in the subglottal cavity move to the supraglottal cavity. This movement of mass is airflow. The airflow will continue until a pressure equilibrium is reached.
7. <u>Glottalic Airstream Mechanism - Closed Cavity</u>: Similarly, in an ejective consonant with a glottalic airstream mechanism, the lips or the tongue, i.e., the buccal or the lingual valve, are initially closed and the closed glottis – the laryngeal position – is raised decreasing the oral cavity volume behind the valve closure and increasing the pressure compared to the volume and the pressure at a resting state.
8. <u>Glottalic Airstream Mechanism - Open Cavity</u>: When the closed valve is opened, airflow will result from the cavity behind the initial closure outward until intra-oral pressure is equal to the atmospheric pressure.
9. <u>Pressure Equalization by Airflow Movement</u>: That is, air will flow from a cavity of higher pressure to a cavity of lower pressure until the equilibrium point; the pressure as potential energy is, thus, converted into airflow as kinetic energy.

Sound Sources

1. Periodic and Aperiodic Sound Sources: Sound sources refer to the conversion of aerodynamic energy into acoustic energy. There are two main types of sound sources in the articulatory system: periodic – or more precisely, semi-periodic, and aperiodic.
2. Origin of Periodic Sound Source: A periodic sound source is a vocal fold vibration produced at the glottis found in vowels and consonants. A less common periodic sound source is the vibration of the oral articulator like the tongue found in alveolar trills.
3. Origin of Aperiodic Sound Source: Aperiodic sound sources are the turbulent noises of fricative consonants and the short-noise burst of plosive releases produced in the oral cavity.
4. Voicing/Unvoicing in Vocal Cords: Voicing is a common period sound source in spoken languages and is related to how closely vocal cords are placed together. In English, there are only two possibilities, *voiced* and *unvoiced*.
5. Vocal Cord Voicing for Vowels: Voicing is caused by vocal cords being held close together, so that air passing through them makes them vibrate. All normally spoken vowels are voiced, as are all sonorants except *h*, as well as some of the remaining sounds (*b, d, g, v, z, zh, j,* and the *th* found in *this*).
6. Origin of Vocal Cord Voicelessness: All the rest are voiceless sounds, with the vocal cords held for enough apart that there is no vibration; however, there is still a certain amount of audible friction, as in the sound *h.*
7. Prominence of Voiceless Speech Sounds: Voiceless sounds are not very prominent unless there is some turbulence, as in stops, fricatives, and affricates; this is why sonorants in general only occur voiced. The exception is during whispering, when all sounds are voiceless.

Periodic Sources

1. <u>Non-vocal Fold Vibration</u>: 20-40 Hz
2. <u>Vocal Fold Vibration</u>:
    a. Lower Limit => 70-80 Hz modal, i.e., bass; 30-40 Hz creaky
    b. Upper Limit => 1170 Hz, i.e., soprano

References

- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Laver, J. (1994): *Principles of Phonetics* **Cambridge University Press** Cambridge, UK
- Wikipedia (2021): Articulatory Phonetics

Auditory Phonetics

Overview

1. Focus of Auditory Phonetics Subfield: *Auditory Phonetics* is the branch of phonetics concerned with the hearing of speech sounds and with speech perception. It thus entails the study of relationships between speech stimuli and a listener's response to such stimuli mediated by the mechanisms of peripheral and the central auditory systems, including certain acoustic areas of the brain (Wikipedia (2021)).
2. One of Three Phonetics Branches: It is said to comprise one of three main branches of phonetics along with acoustic and articulatory phonetics (O'Connor (1973), Mack (2004)).

Physical Scales and Auditory Sensations

1. Auditory Sensation vs. Acoustic Properties: There is no direct connection between the auditory sensations and the physical properties of sound that give rise to them. While the physical/acoustic properties are objectively measurable, auditory sensations are subjective and can only be studied by asking listeners to report on their perceptions (Denes and Pinson (1993)).
2. Physical Property/Auditory Perception Mapping: The table below shows some correspondence between physical properties and auditory sensations.

Physical Property	**Auditory Perception**

Amplitude or Intensity	Loudness
Fundamental Frequency	Pitch
Spectral Structure	Sound Quality
Duration	Length

Segmental and Suprasegmental

1. Segmental/Prosodic Aspects of Speech: Auditory phonetics is concerned with both segmental – chiefly vowels and consonants – and prosodic – such as stress, tone, rhythm, and intonation – aspects of speech. While it is possible to study the auditory perception of these phenomena without context, in continuous speech all these variables are processed in parallel with significant variability and complex interactions between them (Wood (1974), Elman and McClelland (1982)).
2. Example - Intrinsic Frequencies of Vowel Formants: For example, it has been observed that vowels, which are usually described as different from each other in the frequencies of their formants, also have intrinsic values of fundamental frequency – and presumably therefore of pitch – that are different according to the height of the vowel.
3. Fundamental Vowel Frequencies - Open/Cloud: Thus, open vowels have a lower fundamental frequency than closed vowels in a given context (Turner and Verhoeven (2011)), and vowel recognition is likely to interact with the perception of prosody.

In Speech Research

1. Auditory Phonetics vs. Speech Perception: If there is a distinction to be made between auditory phonetics and speech perception, it is that the former is more closely associated with the traditional non-instrumental approaches to phonology and other aspects of linguistics, while the latter is closer to experimental laboratory-based study.
2. Instrument Usage in Auditory Phonetics: Consequently, the term *auditory phonetics* is used to refer to the study of speech without the use of instrumental analysis: the researcher may use if technology such as recording equipment, or even a simple paper and pencil – as used by Labov (1966) in the study of English in New York department stores, but will not use laboratory techniques such as spectrography or speech synthesis, or methods such as EEG and fMRI that allows phoneticians to directly study brain's response to sound.
3. Research using Auditory Analysis: Most research in sociolinguistics and dialectology has ben based on auditory analysis of data, and almost all pronunciation dictionaries are based on impressionistic, auditory analysis of how words are pronounced.
4. Definitions given by Pike/Pilch: It is possible to claim an advantage for auditory analysis over instrumental: "Auditory analysis is essential to phonetic study since the ear can register all those features of sound waves, and only those features, which are above the threshold of audibility … whereas analysis by instruments must always be checked against auditory reaction". Pilch (1978) attempted to define auditory phonetics in such a way as to avoid any reference to acoustic parameters.
5. Auditory Training in Speech Phones: In the auditory analysis of phonetic data such as recordings of speech, it is clearly an advantage to have been trained in analytical listening. Practical phonetic training has since the 19th century been seen as an essential foundation for phonetic analysis and for the teaching of pronunciation; it is still a significant part of modern phonetics.
6. Examples: Trainings in Cardinal Vowels: The best-known system of auditory training has been in the system of cardinal vowels; there is disagreement about the auditory and the articulatory factors in the underlying system, but the importance of auditory training for those who use it are indisputable (Ladefoged (1967)).
7. Training in Prosodic Speech Factors: Training in the auditory analysis of prosodic factors such as pitch and rhythm is also important.

8. Instrumental Approach in Prosody Research: Not all research on prosody has been based on auditory techniques; some pioneering work on prosodic features using laboratory instruments was carried out in 20th century, e.g., Elizabeth Uldall's work on synthesized intonation contours, Fry's work on stress perception (Fry (1954)), or Jones' early work on analyzing pitch contours by means of manually operating the pickup arm of a gramophone to listen repeatedly to individual syllables, checking where necessary against a tuning fork (Jones (1909)).
9. Computer Approaches in Prosody Research: However, a good majority of the work on prosody has been based on the auditory analysis until the recent arrival of approaches explicitly based on computer analysis of the acoustic signal, such as ToBI, INTSINT, or the IPO system (t'Hart, Collier, and Cohen (1996)).

References

- Denes, P., and E. Pinson (1993): *The Speech Chain 2nd Edition* **W. H. Freeman** New York, NY
- Elman, J., and J. McClelland (1982): Exploiting Lawful Variability in the Speech Wave, in: *Invariance and Variability in Speech Processes (Editors: Perkell, J. S., and D. Klatt)* **Erlbaum** Mahwah, NJ
- Fry, D. (1954): Duration and Intensity as Physical correlates of Linguistic Stress *Journal of the Acoustical Society of America* **27 (4)** 765-768
- Jones, D. (1909): *Intonation Curves* **Teubner** Leipzig, Germany
- Labov, W. (1966): *The Social Stratification of English in New York City* **Center for Applied Linguistics** Washington, DC
- Ladefoged, P. (1967): *Three Areas of Experimental Phonetics* **Oxford University Press** Oxford, UK
- Mack, M. (2004): Auditory Phonetics, in: *The Linguistics Encyclopedia (Editor: Malmkjaer, K.)* **Routledge** Oxfordshire, UK

- O'Connor, J. D. (1973): *Phonetics 1st Edition* **Penguin** New York, NY
- Pike, K. (1943): *Phonetics* **University of Michigan** Ann Arbor, MI
- Pilch, H. (1978): Auditory Phonetics *Word* **29 (2)** 148-160
- t'Hart, J., R. Collier, and A. Cohen (1990): *A Perceptual Study of Intonation* **Cambridge University Press** Cambridge, UK
- Turner, P., and J. Verhoeven (2013): Intrinsic Vowel Pitch: A Gradient Feature of Vowel Systems? *Proceedings of the International Congress of Phonetic Sciences* 2038-2041
- Wikipedia (2021): Auditory Phonetics
- Wood, C. C. (1974): Parallel Processing of Auditory and Phonetic Information in Speech Discrimination *Perception and Psychophysics* **15 (3)** 501-508

Speech Production

Overview

1. Translation of Thoughts to Speech: *Speech production* is the process by which thoughts are translated into speech. This includes the selection of words, the organization of relevant grammatical forms, and the articulation of the resulting sounds by the motor system using the vocal apparatus (Wikipedia (2021)).
2. Ways of Initiating Speech Production: Speech production can be spontaneous such as when the person creates the words of a conversation, reactive such as when they name a picture or read aloud a written word, or imitative such as in speech repetition. Speech production is not the same as language production since language can also be produced by signs.
3. Speech Rate in Normal Conversation: In ordinary fluent conversation people pronounce roughly four syllables, ten to twelve phonemes, and two to three words from their vocabulary – which can contain 10 to 100 thousand words – each second (Levelt (1999a)).
4. Frequency of Speech Production Errors: Errors in speech production are relatively rare occurring at the rate of once every 900 words in spontaneous speech (Garnham, Shillcock, Brown, Mill, and Culter (1981)).
5. Factors determining the Speed of Speech: Words that are commonly spoken or learned early in life or easily imagined are quicker to say than ones that are rarely said, learned later in life, or are abstract (Oldfield and Wingfield (1965), Bird, Franklin, and Howard (2001)).
6. Speech Production through Pulmonic Airflow: Normally speech is created with pulmonary pressure provided by the lungs that generates sound by phonation through the glottis in the larynx that is then modified by the vocal tract into different vowels and consonants.
7. Non-pulmonic Means of Speech Production: However, speech production can occur without the use of lungs in glottis in alaryngeal speech by using the upper parts of the vocal tract. An

example of such alaryngeal speech is Donald Duck talk (Weinberg and Westerhouse (1971, 1972)).

8. Speech Augmented with Hand Gestures: The vocal production of speech may be associated with the production of hand gestures that act to enhance the comprehensibility of what is being said (McNeill (2005)).
9. Holophrastic Phase of Speech Development: The development of speech production throughout an individual's life starts from an infant's first babble and is transformed into fully developed speech by the age of five (Harley (2011)). This first stage of speech – the holophrastic phase – does not occur until around age one.
10. Telegraphic Phase of Speech Development: Between the ages of one and a half and two and a half, in he telegraphic phase, the infant can produce short sentences. After two and a half years the infant develops systems of lemmas used in speech production.
11. Enhancement of Child's Word Lemmas: Around four or five the child's lemmas are largely increased, and this enhances the child's production of correct speech and they can now produce speech like an adult.
12. Stage in Adult Speech Development: An adult now develops speech in four stages: activation of lexical concepts, select lemmas needed, morphologically and phonologically encode speech, and the word is phonetically encoded (Harley (2011)).

Three Stages

1. Major Levels of Speech Production: The production of spoken language involves three major levels of processing: conceptualization, formulation, and articulation (Levelt (1989, 1999a), Jescheniak and Levelt (1994)).
2. Conceptualization or Conceptual Message Preparation: The first is the process of conceptualization or conceptual message preparation, in which the intention to create speech links a desired concept to the particular spoken words to be expressed. Here the preverbal intended messages are formulated that specify the concepts to be expressed (Levelt (1999b)).

3. Formulation of the Linguistic Form: The second stage is the formulation in which the linguistic form required for the expression of the desired message is created. Formulation includes grammatical encoding, morpho-phonological encoding, and phonetic level encoding (Levelt (1999b)).
4. Formulation Stage #1 - Grammatical Encoding: Grammatical encoding is the process of selecting the appropriate word or lemma. The selected lemma then activates the appropriate syntactic frame for the conceptualized message.
5. Formulation Stage #2 - Morpho-phonological Encoding: Morpho-phonological encoding is the process of breaking down words into syllables to be produced during overt speech. Syllabification is dependent on the preceding and the proceeding words, for instance: *I-com-pre-hend* vs. *I-com-pre-hen-dit* (Levelt (1999b)).
6. Formulation Stage #3 - Phonetic Encoding: The final part of the formulation stage is phonetic encoding. This involves the activation of the articulatory gestures dependent on the syllables selected in the morpho-phonological process, creating an articulatory score as the utterance is pieced together and the order of movements of the vocal apparatus is completed (Levelt (1999b)).
7. Execution of the Articulatory Score: The third stage of speech production is articulation, which is the execution of the articulatory score by lungs, glottis, larynx, tongue, lips, jaw, and other parts of the vocal apparatus resulting in speech (Levelt (1989, 1999)).

Neuroscience

1. Motor Control for Speech Production: The motor control for speech production in right-handed people depends mostly on the areas in the left cerebral hemisphere. These areas include the bilateral supplementary motor area, the left posterior inferior frontal gyrus, the left insula, the left primary motor cortex, and the temporal cortex (Indefrey and Levelt (2004)).

2. Role of Cerebellum/Subcortical Areas: There are also subcortical areas involved such as the basal ganglia and the cerebellum (Booth, Wood, Lu, Houk, and Bitan (2007), Ackermann (2008)). The cerebellum aids the sequencing of speech variables into fast, smooth, and rhythmically organized words and longer utterances.

Evolution of Speech Production Research

1. Speech Synthesis from Error Data: Until the late 1960s research on speech was focused on comprehension. As researchers collected greater volumes of speech error data, they began to investigate the psychological processes responsible for the production of speech sounds and to contemplate possible processes for fluent speech (Fromkin and Bernstein-Ratner (1998)). Findings from speech error research were soon incorporated into speech production models. Evidence from speech error data supports the following conclusions about speech production.
2. Speech in Planned in Advance: See Fromkin and Bernstein-Ratner (1998).
3. Semantic and Phonological Lexicon Organization: The lexicon is organized both semantically and phonologically (Fromkin and Bernstein-Ratner (1998)). That is by meaning, and the sound of words.
4. Morphologically Complex Words are Assembled: Words that we produce that contain morphemes are put together during the speech production process. Morphemes are the smallest units of language that contain meaning. For example, *ed* in a past tense word (Fromkin and Bernstein-Ratner (1998)).
5. Affixes and Functors behave Differently: The behavior is different from the context words in the slips of tongue (Fromkin and Bernstein-Ratner (1998)). This means rules about the ways in which words can be used are likely stored with them, which means that generally when speech errors are made, the mistaken words maintain their function and make grammatical sense.

6. Speech Errors Reflect Rule Knowledge: The words and sentences that are produced in speech errors are typically grammatical, and do not violate the rules of the language being spoken.

Aspects of Speech Production Models

1. Elements Expected of Speech Models: Models of speech production must contain specific elements to be viable. These include the elements from which speech is composed, listed below. The accepted models of speech production discussed in more detail later all incorporate these stages explicitly or implicitly, and the ones that are now outdated or disputed have been criticized for overlooking one or more of the following stages (Field (2004)).
2. Element #1 - The Conceptual Stage: The first attribute of an accepted speech model is a conceptual stage where the speaker identifies what they wish to express (Field (2004)).
3. Element #2 - The Syntactic Stage: The next is a syntactic stage, where a frame is chosen that words will be place into; this frame is usually a sentence structure (Field (2004)).
4. Element #3 - The Lexical Stage: The lexical stage is where the search for a word occurs based on its meaning. Once the word is selected and retrieved, information about it becomes available to the speaker including its phonology and morphology (Field (2004)).
5. Element #4 - The Phonological Stage: In the phonological stage the abstract information is converted into a speech-like form (Field (2004)).
6. Element #5 - The Phonetic Stage: In this stage, the instructions are prepared to be sent to the muscles of articulation (Field (2004)).
7. Auxiliary Mechanisms Complementing Speech Production: Also, models must allow for forward planning mechanisms, a buffer, and a monitoring mechanism.
8. Influential Models of Speech Production: Following are a few of the influential models of speech production that account for or incorporate the previously mentioned stages and

include information discovered as a result of speech error studies and other disfluency data (Fromkin and Bernstein-Ratner (1998)), such as the tip-of-the-tongue research.

The Utterance Generator Model (1971)

1. <u>Stages in Utterance Generator Model</u>: The Utterance Generator Model was proposed by Fromkin (Fromkin and Bernstein-Ratner (1998)). It is composed of six stages and was an effort to account for previous findings of speech error research.
2. <u>First Stage - The Conceptual Message</u>: The stages of the Utterance Generator Model were based on the possible changes in representations of a particular occurrence. The first stage is where the person generates the meaning of the message they wish to convey.
3. <u>Second Stage - The Syntactic Outline</u>: The second stage involves the message being translated into a syntactic structure. Here, the message is given an outline (Fromkin (1998)).
4. <u>Third Stage - The Segmental Features</u>: The third stage proposed by Fromkin is where/when the message gains different stresses and intonations based on meaning.
5. <u>Fourth Stage - The Lexical Selection</u>: The fourth stage Fromkin suggests is concerned with the selection of words from the lexicon. After the words have been selected in Stage 4, the message undergoes phonological specification (Fromkin (1998)).
6. <u>Fifth Stage - Pronunciation/Syllable Rules</u>: The fifth stage applies rules of pronunciation and produces syllables that are to be output.
7. <u>Sixth Stage - Articulatory Score Commands</u>: The sixth and the final stage of the Fromkin model is the coordination of motor commands necessary for speech. Here the phonetic features of the message are sent to the relevant muscles of the vocal tract so that the intended messages can be produced.
8. <u>Criticisms of the Fromkin Model</u>: Despite the ingenuity of the model, researchers have criticized this interpretation of speech production. Although the Utterance Generator Model accounts for many nuances and fata found in speech error studies, researchers decided that it still has room to be improved (Garrett (1975), Butterworth (1982)).

The Garrett Model (1975)

1. Motivation behind the Garrett Model: A more recent attempt than Fromkin to explain speech production was published by Garrett in 1975 (Fromkin and Bernstein-Ratner (1998)). Garrett also created this by compiling speech error data. There are many overlaps between this model and the Fromkin model, from which it was based, but he added a few things to the Fromkin model that filled some of the gaps being pointed out by other researchers.
2. Commonality with the Fromkin Model: The Garrett and the Fromkin models both distinguish between three levels – a conceptual level, a sentence level, and a motor level. These three levels are common to the contemporary understanding of speech production.

Dell's Model (1994)

1. Dell's Model of Lexical Network: In 1994, Dell proposed a model of the lexical network that became fundamental in the understanding of the way speech is produced (Levelt (1999a)). This model of the lexical network attempts to symbolically represent the lexicon, explain how people choose the words they wish to produce, and how these words are to be organized into speech.
2. Stages in the Dell's Model: Dell's model is composed of three stages – semantics, words, and phonemes.
3. The Semantic Category Model Stage: The words in the highest stage of the model represent the semantic category. For example, the words winter, footwear, feet, and snow represent the semantic categories of boot and skate.

4. The Semantic Category Representation Stage: The second level represents the words that refer to the semantic categories – in the example above, boot and skate.
5. The Semantic Category Representation Phonemes: And, the third level represents the phonemes, including syllabic information containing onset, vowels, and codas (Dell (1997)).

Levelt Model (1999)

1. Refinement of the Dell's Model: Levelt further refined the lexical network model proposed by Dell. Through the use of speech error data, Levelt recreated the three levels in Dell's model.
2. Stage #1 - The Conceptual Stratum: The conceptual stratum, the top and the most abstract level, contains information a person has about ideas on particular concepts (Levelt (1999a)). The conceptual stratum also contains ideas about how concepts relate to each other. This is where a word selection would occur, a person would choose which words they wish to use to express.
3. Stage #2 - The Lemma Stratum: The next, or the middle-level, the lemma stratum, contains information about syntactic functions of individual words including tense and form (Levelt (1999a)). This level functions to maintain syntax and to place words correctly into sentence structure that makes sense to the speaker.
4. Stage #3 - The Form Stratum: The lowest and the final level is the form stratum which, similar to the Dell model, contains syllabic information. From here, the information stored at the form stratum level is sent to the motor cortex where the vocal apparatus are coordinated to physically produce speech sounds.

Places of Articulation

1. Components of the Places of Articulation: The physical structure of human nose, throat, and vocal cords allows for the production of many unique sounds; these areas can be broken down further into places of articulation.
2. Speech is a Psychomotor Activity: Different sounds are produced in different areas, with different muscles and breathing techniques (Keren (2011)). Our ability to utilize these skills to create various sounds needed to communicate effectively is essential to speech production.
3. Characteristics of Conversation Impacting Speech: Speech between two people is a conversation – they can be casual, formal, factual, or transactional, and the language structure/narrative employed differs depending upon the context.
4. Psychosomatic Affect Factors Impacting Speech: Affect is a significant factor that controls speech, and manifestations that disrupt memory use due to affect include feelings of tension, states of apprehension, as well as physical signs like nausea.
5. Language Level Manifestations of Affect: Language-level manifestations that affect brings could be observed with the speaker’s hesitations, repetitions, false starts, incompletion, syntactic blends, etc. Difficulties in manner of articulation can contribute to speech difficulties and impediments (Harrison (2011)). It is suggested hat infants are capable of making the entire spectrum of possible vowel and consonant sounds.
6. Advantages of the IPA Representation: IPA has created a system for understanding and categorizing all possible speech sounds, which includes information about the way in which sound is produced (Harrison (2011)). This is extremely useful in the understanding of speech production because speech can be transcribed based on sounds rather than spelling, which may be misleading depending on the language being spoken.
7. Range of Typical Speech Rates: Average speaking rates are in the 120-150 words per minute – wpm – range, and the same is the recommended guidelines for reading audiobooks.
8. Decay/Phasing Out Speech Sounds: As people grow accustomed to a particular language, they are prone to lose not only the ability to produce sounds, but also to distinguish between these sounds (Harrison (2011)).

Articulation

1. Characteristics of Well-articulated Speech: Articulation, often associated with speech production, is how people physically produce speech sounds. For people who speak fluently, articulation is automatic and allows 15 speech sounds to be produced each second (Field (2004)).
2. Elements of Effective Speech Articulation: An effective articulation of speech includes the following elements – fluency, complexity, accuracy, and comprehensibility (Hughes and Reed (2016)).
3. Fluency: This is the ability to communicate an intended message, or to affect the listener in such a way that is intended by the speaker. While accurate use of the language is an element in this ability, over-attention to accuracy will actually inhibit the development of fluency.
4. Fillers/Speech Stretch/Coherent Utterances: Fluency involves constructing coherent utterances and stretches of speech, to respond and to speak without undue hesitation, i.e., limited use of fillers such as *uh, er, eh*, *like,* or *you know*.
5. Simplification, Gesturing, and Appropriate Diction: It also involves the ability to use strategies such as simplification and gesturing to aid communication. Fluency also involves the use of relevant information, appropriate vocabulary, and syntax.
6. Complexity: Speech where the message is communicated properly. Ability to adjust the message or negotiate the control conversation according to the responses of the listener, and use subordination and clausal forms appropriate per the roles and the relationships between the speakers.
7. Sociolinguistic Components of Articulation Complexity: Complexity includes the use of sociolinguistic knowledge – the skills required to communicate effectively across cultures, and norms – the knowledge of what is appropriate to say and in what situations and to whom.
8. Accuracy: This refers to the use of proper and advanced grammar; subject-verb agreement; word order; and word form, i.e., exciting/excited, as well as appropriate word choice in spoken language. It is also the ability to self-correct during discourse, to clarify or modify spoken language for grammatical accuracy.

9. Comprehensibility: This is the ability to be understood by others. It is related to the sound in the language. There are three components that influence one's comprehensibility, and they are:
10. Comprehensibility - Pronunciation: Saying the sounds of the words correctly.
11. Comprehensibility - Intonation: Applying proper stress on words and syllables, using rising and falling pitch to indicate questions or statements, using voice to indicate emotions or emphasis, and speaking with an appropriate rhythm.
12. Comprehensibility - Enunciation: Speaking clearly at an appropriate pace, with effective articulation of words and phrases with appropriate volume.

Development

1. Infant's Early Sound Production Attempts: Before even producing a sound, infants imitate facial expressions and movements (Redford (2015)). Around 7 months of age, infants start to experiment with communicative sounds by trying to coordinate producing sound with opening and closing sounds.
2. Production of the Babbling Sounds: Until the first year of life infants cannot produce coherent words, instead they produce a recurring babbling sound. Babbling allows the infant to experiment with articulating sounds without having to attend to meaning.
3. Importance of the Babbling Sounds: Babbling works with object permanence and understanding of location to support the networks of out first lexical items or words (Harley (2011)). The infant's vocabulary growth increases substantially when they are able to understand that objects exist even when they are not present.
4. Holophrastic Stage of Infant Speech: The first stage of meaningful speech does not occur until the age of one. This stage is the holophrastic phase (Shaffer, Wood, and Willoughby (2005)). The holistic stage refers to when the infant speech consists of one word at a time, i.e., papa.

5. Telegraphic Stage of Infant Speech: In this stage, the infant can form short sentences, e.g., daddy sit, mommy drink. This typically occurs between the ages of one and a half and two and a half. This stage is particularly noteworthy because of the explosive growth of their lexicon.
6. Accessing Stored Representation of Words: During this stage, infants must select and match stored representations of words to the specific perceptual target word in order to convey meaning of concepts (Redford (2015)).
7. Enhanced Learning through Phonological Decomposition: With enough vocabulary, infants begin to extract sound patterns, and they learn to break down words into phonological segments, increasing further the number of words they can learn (Harley (2011)). At this point in an infant's speech their lexicon consists of 200 words or more and they are able to understand even more than they can speak (Shaffer, Wood, Willoughby (2005)).
8. Development of the Detailed Semantic Network: When they reach two and a half years their speech becomes increasingly complex, particularly in its semantic structure. With a more detailed semantic network the infant learns to express a wider range of meanings, helping the infant develop a complex conceptual system of lemmas.
9. Wider Range of Lemma Diversity: Around the age of four or five the child lemmas have a wider range of diversity, and this helps them to select the right lemma needed to produce correct speech (Harley (2011)).
10. Actively Enriching the Infant's Diction: Reading to infants enhances their lexicon. At this stage children who have been read to and are exposed to more uncommon and complex words have acquired many more words than a child that is linguistically impoverished (Wolf (2005)). At this stage the child should be able to speak in full complete sentences, similar to an adult.

References

- Ackermann, H. (2008): Cerebellar Contributions to Speech Production and Speech Perception: Psycholinguistic and Neurobiological Perspectives *Trends in Neurosciences* **31 (6)** 265-272
- Bird, H., S. Franklin, and D. Howard (2001): Age of Acquisition and Imageability of Ratings for a large Set of Words, including Verbs and Function Words *Behavior Research Methods, Instruments, and Computers* **33 (1)** 73-79
- Booth, J. R., L. Wood, D. Lu, J. C. Houk, and T. Bitan (2007): The Role of the Basal Ganglia and Cerebellum in Language Processing *Brain Research* **1133 (1)** 136-144
- Butterworth, B. (1982): *Psycholinguistics* **Harcourt Brace College Publishers** San Diego, CA
- Dell, G. S. (1997): Analysis of Sentence Production *Psychology of Learning and Motivation* **9** 133-177
- Field, J. (2004): *Psycholinguistics* **Routledge** Milton Park, UK
- Fromkin, V. (1998): *Utterance Generator Model of Speech Production in Psycholinguistics 2nd Edition* **Harcourt Brace College Publishers** San Diego, CA
- Fromkin, V. and N. Bernstein-Ratner (1998): *Speech production and Processing Models* **Harcourt Brace College Publishers** San Diego, CA
- Garrett, M. F. (1975): *The Garrett Model in Psycholinguistics* **Harcourt Brace College Publishers** San Diego, CA
- Garnham, A., R. C. Shillcock, G. D. A. Brown, A. I. D. Mill, and A. Culter (1981): Slips of the tongue in London-Lund Corpus of Spontaneous Conversation *Linguistics* **19 (7-8)** 805-817
- Harley, T. A. (2011): *Psycholinguistics Volume I* **SAGE Publications** Thousand Oaks, CA
- Harrison, A. E. (2011): *Speech Disorders: Causes, Treatments, and Social Effects* **Nova Science Publishers**, New York, NY
- Hughes, R., and B. S. Reed (2016): *Teaching and Researching Speaking 3rd Edition* **Taylor and Francis** Milton Park, UK
- Indefrey, P. and W. J. M. Levelt (2004): The Spatial and Temporal Signatures of Word Production Components *Cognition* **92 (1-2)** 101-144

- Jescheniak, J. D. and W. J. M. Levelt (1994): Word Frequency Effects in Speech Production: Retrieval of Syntactic Information and of Phonological Form *Journal of Experimental Psychology: Learning, Memory, and Cognition* **20 (4)** 824-843
- Keren, R. (2011): *Consonantal Place of Articulation* **John Wiley and Sons** Hoboken, NJ
- Levelt, W. J. M. (1989): *Speaking: From Intention to Articulation* **MIT Press** Cambridge, MA
- Levelt, W. J. M. (1999a): Models of Word Production *Trends in Cognitive Sciences* **3 (6)** 223-232
- Levelt, W. J. M. (1999b): *The Neurocognition of Language* **Oxford University Press** Oxford, UK
- McNeill, D. (2005): *Gesture and Thought* **University of Chicago Press** Chicago, IL
- Oldfield, R. C. and A. Wingfield (1965): Response Latencies in Naming Objects *Quarterly Journal of Experimental Psychology* **17 (4)** 273-281
- Redford, M. A. (2015): *The Handbook of Speech Production* **John Wiley and Sons** Malden, MA
- Shaffer, D., E. Wood, and T. Willoughby (2005): *Developmental Psychology Childhood and Adolescence 2nd Canadian Edition* **Nelson** Toronto, ON
- Weinberg, B. and J. Westerhouse (1971): A Study of Buccal Speech *Journal of Speech and Hearing Research* **14 (3)** 652-658
- Weinberg, B. and J. Westerhouse (1972): A Study of Buccal Speech *Journal of the Acoustical Society of America* **51 (1A)** 91
- Wolf, M. (2005): *Proust and the Squid: The Story and the Science of the Reading Brain* **Harper** New York, NY
- Wikipedia (2021): Speech Production

Consonant

Overview

1. Consonants from Vocal Tract Closure: A *consonant* is a speech sound that is articulated with a complete or partial closure of the vocal tract (Wikipedia (2021)).
2. Examples of Consonant Generating Organs: Examples are [p], pronounced with the lips; [t], pronounced with the front of the tongue; [k], pronounced with the back of the tongue; [h], pronounced in the throat; [f] and [s], pronounced by forcing air through a narrow channel, i.e., fricatives; and [m] and [n], which have air flowing through the nose, i.e., nasals. Contrasting against consonants are vowels.
3. Assignment of Symbols to Consonants: Since the number of speech sounds in the world's languages is much greater than the number of letters in any one alphabet, linguists have devised systems such as the IPA to assign a unique and unambiguous symbol to each attested consonant.
4. Consonant Representation using Multiple Letters: The English alphabet has fewer letters than the English language has consonant sounds, so digraphs like <ch>, <sh>, <th>, and <ng> are used to extend the alphabet, though some letters and digraphs represent more than one consonant.
5. Example - Distinguishing *This* from *Thin*: For example, the sound spelt "th" in *this* is a different consonant from the "th" sound in *thin*. In the IPA, these are [ð] and [θ], respectively.

Consonant *Sounds* and Consonant *Letters*

1. Consonant Letters in English: The word *consonant* may be used unambiguously for both speech sounds and the letters of the alphabet used to write them. In English, these letters are B, C, D, F, G, H, J, K, L, M, N, P, Q, S, T, V, X, Z, and often H, R, W, Y.
2. H, R, W, Y, GH: In English orthography, the letters H, R, W, Y, and the digraph <GH> are used for both consonants and vowels. For instance, the letter Y stands for the consonant /j/ in ***y**oke*, the vowel /ɪ/ in ***m**yth*, the vowel /i/ in *funn**y***, the diphthong /aɪ/ in *sk**y***, and forms several digraphs for other diphthongs, such as *sa**y***, *bo**y***, *ke**y***. Similarly, R commonly indicates or modifies a vowel in non-rhotic consonants.
3. Consonant Sounds - Focus of the Chapter: This chapter is concerned with consonant sounds, however they are written.

Consonants and Vowels

1. Sonorant Components of a Consonant: Consonants and vowels correspond to distinct parts of a syllable. The most sonorous part of the syllable, i.e., the part that is part easiest to sing, called the *syllabic peak* or *nucleus*, is typically a vowel, while then less sonorous margins – called the *onset* and the *coda* – are typically consonants.
2. Consonant/Vowel Syllabic Component Sequences: Such syllables may be abbreviated as CV, V, and CVC, where C stands for a consonant and V stands for a vowel. This can be argued to be the only pattern found in most of the world's languages, and perhaps the primary pattern in all of them.
3. Syllabic Consonants and Non-syllabic Vowels: However, the distinction between consonant and vowel is not always clear-cut; there are syllabic consonants and non-syllabic vowels in many of the world's languages.
4. Semivowel, Semi-consonant, and Glide Segments: One blurry area is in segments variously called *semivowels*, *semi-consonants*, or *glides*.

5. Non-syllabic Vowel-like Segments: On the one side, there are vowel-like segments that are not in themselves syllabic, but form diphthongs as part of the syllabic nucleus, as the *i* in the English *boil*.
6. Approximants Articulated Similar to Vowels: On the other hand, there are approximants that behave as consonants in forming onsets, but are articulated very much like vowels, as the *y* in English *yes*.
7. Vowel-Based Syllable Phonology Specification: Some phonologists treat these as both being the underlying vowel /i/, so that the English word *bit* would phonemically be /bit/, *beet* would be /bi[i over u]t/, and *yield* would be /[i over u]i[i over u]ld/. Likewise, *foot* would be /fut/, *food* would be /fuu̯d/, *wood* would be /u̯ud/, and *wooed* would be /u̯uu̯d/.
8. Semivowel Based Syllable Phonology Specification: However, there is a – perhaps allophonic – difference in articulation between these segments, with the [j] in *yes* and *yield* and the [w] of *wooed* having more constriction and a more definite place of articulation than the [i] in *boil* or *bit* of the [ʊ] of *foot*.
9. Consonants Occupying the Syllable Nucleus: The other problematic area is that of syllabic consonants, segments articulated as consonants but occupying the nucleus of a syllable.
10. Syllabic Consonants vs. Rhotic Vowels: This may be the case for words such as *church* in rhotic dialects of English, although phoneticians differ in whether they consider this to be syllabic consonant or a rhotic vowel.
11. Distinguishing Approximants from Rhotic Vowels: Some distinguish an approximant /ɹ/ that corresponds to a vowel /ɝ/, for *rural* as either; others see this as a single phoneme.
12. Fricatives/Trills as Syllabic Nuclei: Other languages fricative and often trilled segments as syllabic nuclei, as in Czech and several languages in the Democratic Republic of Congo, and China, including Mandarin Chinese. In Mandarin, they are historically allophones of /i/, and spelt that way in Pinyin.
13. Phonetically Consonant but Phonemically Vowel: Ladefoged and Maddieson (1996) call these “fricative vowels” and say that “they can usually be thought of as syllabic fricatives that are allophones of vowels”. That is, phonetically they are consonants, but phonemically they behave as vowels.
14. Trills/Laterals as Syllabic Nuclei: Many Slavic languages allow the trill [r] and the lateral [l] as syllabic nuclei.

15. Location of the Syllabic Nucleus: In languages such as Nuxalk, it is difficult to know what the nucleus of a syllable is, or if all syllables even have nuclei. If the concept of ‘syllable’ applies in Nuxalk, there are syllabic consonants in words like /sxs/ ‘seal fat’.
16. Words without Vowels - Miyako Language: Miyako in Japan is similar, with /fks/ ‘to build’ and /psks/ ‘to pull’.

Features

1. Phonetic Features of Spoken Consonants: Each spoken consonant can be distinguished by several phonetic features.
2. Consonant/Approximant Manner of Articulation: The manner of articulation is how air escapes from the vocal tract when the consonant or the approximant/vowel-like sound is made. Manners include stops, fricatives, and nasals.
3. Place of Articulation and Coarticulation: The place of articulation is where in the vocal tract the obstruction of the consonant occurs, and which speech organs are involved. Places includes bilabial – both lips, alveolar – tongue against the gum ridge, and velar – tongue against the soft palate. In addition, there may be a simultaneous narrowing at another place of articulation, such as palatalization or pharyngealization. Consonants with two simultaneous places of articulation are said to be coarticulated.
4. Consonant Phonation - Voicing and Voiceless: The phonation of a consonant is how the vocal cords vibrate during the articulation. When the vocal cords vibrate fully, the consonant is called voiced; when they do not vibrate at all, it is voiceless.
5. Voice Onset Time and Aspiration: The voice onset time VOT indicates the timing of the phonation. Aspiration is a feature of VOT.
6. Pulmonic/Ejective/Click/Implosive Airstreams: The airstream mechanism is how the air moving through the vocal tract is powered. Most languages have exclusively pulmonic egressive consonants, which use the lungs and the diaphragm, but ejectives, clicks, and implosives use a different mechanism.

7. Length of Obstruction in Consonant: The length is how long the obstruction of a consonant lasts. This feature is borderline distinctive in English, as in *wholly* vs. *holy*, but cases are limited to morpheme boundaries. Unrelated roots are differentiated in various languages such as Italian, Japanese, and Finnish with two levels, *single* and *geminate*. Estonian and some Sami languages have three lengths: short, geminate, and long geminate, although the distinction between geminate and overlong geminate includes suprasegmental features.
8. Muscular Energy in Articulatory Force: The articulatory force is how much muscular energy is involved. This has been proposed many times, but no distinction relying exclusively on force has ever been demonstrated.
9. Comprehensive Specification of English Consonants: All English consonants can be specified by a combination of these features, such as "voiceless alveolar stop" [t]. In this case, the airstream mechanism is omitted.
10. Fortis/Lenis Consonant Pair Specification: Some pairs of consonants like *p::b*, *t::d* are sometimes called fortis and lenis, but this is a phonological rather than phonetic distinction.
11. Consonant Feature Specification using IPA: Consonants are scheduled by their features in a number of IPA charts. Both voiced and voiceless are captured in these charts. Place/manner of articulations not specified in these charts are judged impossible.

IPA: Pulmonic Consonants

1. Bilabial Nasal:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Labial	Nasal	m | m̥

2. Labiodental Nasal:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Labial	Nasal	ɱ

3. Linguolabial Nasal:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Labial/Coronal	Nasal	n double cup below

4. Alveolar Nasal:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Nasal	ṇ | n

5. Retroflex Nasal:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Nasal	[ɳ below ampersand] | ɳ

6. Palatal Nasal:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal/Dorsal	Nasal	ɲ | [ɲ below ampersand]

7. Velar Nasal:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Dorsal	Nasal	[ŋ below ampersand] | ŋ

8. Uvular Nasal:

Place of Articulation	**Manner of Articulation**	**Voiced/Voiceless**
Dorsal	Nasal	ɴ

9. Bilabial Plosive:

Place of Articulation	**Manner of Articulation**	**Voiced/Voiceless**
Labial	Plosive	p | b

10. Labiodental Plosive:

Place of Articulation	**Manner of Articulation**	**Voiced/Voiceless**
Labial	Plosive	[p above open slab] | [b above open slab]

11. Linguolabial Plosive:

Place of Articulation	**Manner of Articulation**	**Voiced/Voiceless**
Labial/Coronal	Plosive	[t above double cup] | [b above double cup]

12. Alveolar Plosive:

Place of Articulation	**Manner of Articulation**	**Voiced/Voiceless**
Coronal	Plosive	t | d

13. Retroflex Plosive:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Plosive	ʈ | ɖ

14. <u>Palatal Plosive</u>:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Plosive	c | ɟ

15. <u>Velar Plosive</u>:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal/Dorsal	Plosive	k | g

16. <u>Uvular Plosive</u>:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Dorsal	Plosive	q | ɢ

17. <u>Pharyngeal/Epiglottal Plosive</u>:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Laryngeal	Plosive	ʡ

18. <u>Glottal Plosive</u>:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Laryngeal	Plosive	ʔ

19. Alveolar Sibilant Plosive:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Sibilant Affricate	ʦ | ʣ

20. Postalveolar Sibilant Plosive:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Sibilant Affricate	t̠ʃ | d̠ʒ

21. Retroflex Sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Sibilant Affricate	ʈʂ | ɖʐ

22. Bilabial Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Labial	Non-sibilant Affricate	pφ | bβ

23. Labiodental Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Labial	Non-sibilant Affricate	[p above open slab]f | [b above open slab]v

24. Dental Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Non-sibilant Affricate	[t above open slab]ɵ | [d above open slab]ð

25. Alveolar Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Non-sibilant Affricate	t[IPA Symbol Check] | d[IPA Symbol Check]

26. Postalveolar Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal	Non-sibilant Affricate	t̠[IPA Symbol Check] | d̠[IPA Symbol Check]

27. Palatal Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Coronal/Dorsal	Non-sibilant Affricate	cç | ɟʝ

28. Velar Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Dorsal	Non-sibilant Affricate	kx | gɣ

29. Uvular Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced/Voiceless
Dorsal	Non-sibilant Affricate	qX | ɢʁ

30. Pharyngeal/Epiglottal Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiced
Laryngeal	Non-sibilant Affricate	ʡ | ʢ

31. Glottal Non-sibilant Affricate:

Place of Articulation	Manner of Articulation	Voiceless
Laryngeal	Non-sibilant Affricate	ʔh

32. Alveolar Sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Sibilant Fricative	s | z

33. Postalveolar Sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Sibilant Fricative	ʃ | ʒ

34. Retroflex Sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Sibilant Fricative	ʂ | ʐ

35. Palatal Sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal/Dorsal	Sibilant Fricative	ɕ | ʑ

36. Bilabial Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Labial	Non-sibilant Fricative	φ | β

37. Labiodental Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Labial	Non-sibilant Fricative	f | v

38. Linguolabial Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Labial/Coronal	Non-sibilant Fricative	

39. Dental Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Non-sibilant Fricative	ɵ | ð

40. Alveolar Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Non-sibilant Fricative	ɵ right bottom bar | ð right bottom bar

41. Postalveolar Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Non-sibilant Fricative	IPA 151 404 402A 429

42. Retroflex Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiced
Coronal	Non-sibilant Fricative	IPA 152 429

43. Palatal Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal/Dorsal	Non-sibilant Fricative	ç | ʝ

44. Velar Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Dorsal	Non-sibilant Fricative	x | ɣ

45. Uvular Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Dorsal	Non-sibilant Fricative	χ | ʁ

46. Pharyngeal/Epiglottal Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Laryngeal	Non-sibilant Fricative	ħ | ʕ

47. Glottal Non-sibilant Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Laryngeal	Non-sibilant Fricative	h | ɦ

48. Labiodental Approximant:

Place of Articulation	Manner of Articulation	Voiced
Labial	Approximant	ʋ

49. Alveolar Approximant:

Place of Articulation	Manner of Articulation	Voiced
Coronal	Approximant	ɹ

50. Retroflex Approximant:

Place of Articulation	Manner of Articulation	Voiced
Coronal	Approximant	ɻ

51. Palatal Approximant:

Place of Articulation	Manner of Articulation	Voiced
Coronal/Dorsal	Approximant	j

52. Velar Approximant:

Place of Articulation	Manner of Articulation	Voiced
Dorsal	Approximant	ɰ

53. Glottal Approximant:

Place of Articulation	Manner of Articulation	Voiced
Laryngeal	Approximant	No Unicode/hex?

54. Bilabial Tap/Flap:

Place of Articulation	Manner of Articulation	Voiced
Labial	Tap/Flap	ⱱ̟

55. Labiodental Tap/Flap:

Place of Articulation	Manner of Articulation	Voiced
Labial	Tap/Flap	ⱱ

56. Linguolabial Tap/Flap:

Place of Articulation	Manner of Articulation	Voiced
Labial/Coronal	Tap/Flap	No Unicode/hex?

57. Alveolar Tap/Flap:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Tap/Flap	No Unicode/hex? | ɾ

58. Retroflex Tap/Flap:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Tap/Flap	ɽ̊ | ɽ

59. Uvular Tap/Flap:

Place of Articulation	Manner of Articulation	Voiced
Dorsal	Tap/Flap	ɢ̆

60. Pharyngeal/Epiglottal Tap/Flap:

Place of Articulation	Manner of Articulation	Voiced
Laryngeal	Tap/Flap	ʡ̆

61. Bilabial Trill:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Labial	Trill	ʙ̥ | ʙ

62. Alveolar Trill:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Trill	r̥ | r

63. Retroflex Trill:

Place of Articulation	**Manner of Articulation**	**Voiceless/Voiced**
Coronal	Trill	ɽ̥r̥ | ɽr

64. Uvular Trill:

Place of Articulation	**Manner of Articulation**	**Voiceless/Voiced**
Dorsal	Trill	ʀ̥ | ʀ

65. Pharyngeal/Epiglottal Trill:

Place of Articulation	**Manner of Articulation**	**Voiceless/Voiced**
Laryngeal	Trill	ʜ | ʢ

66. Alveolar Lateral Fricative:

Place of Articulation	**Manner of Articulation**	**Voiceless/Voiced**
Coronal	Lateral Fricative	ɬ | ɮ

67. Retroflex Lateral Fricative:

Place of Articulation	**Manner of Articulation**	**Voiceless/Voiced**
Coronal	Lateral Fricative	No Unicode/Hex?

68. Palatal Lateral Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal/Dorsal	Lateral Fricative	ʎ̥˔ | ʎ˔

69. Velar Lateral Fricative:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Dorsal	Lateral Fricative	No Unicode/Hex?

70. Alveolar Lateral Affricate:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Lateral Affricate	tɬ | dɮ

71. Retroflex Lateral Affricate:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Lateral Affricate	No Unicode/Hex?

72. Palatal Lateral Affricate:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal/Dorsal	Lateral Affricate	cʎ̥˔ | ɟʎ˔

73. Velar Lateral Affricate:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Dorsal	Lateral Affricate	No Unicode/Hex?

74. Alveolar Lateral Approximant:

Place of Articulation	Manner of Articulation	Voiced
Coronal	Lateral Approximant	l

75. Retroflex Lateral Approximant:

Place of Articulation	Manner of Articulation	Voiced
Coronal	Lateral Approximant	ɭ

76. Palatal Lateral Approximant:

Place of Articulation	Manner of Articulation	Voiced
Coronal/Dorsal	Lateral Approximant	ʎ

77. Velar Lateral Approximant:

Place of Articulation	Manner of Articulation	Voiced
Dorsal	Lateral Approximant	ʟ

78. Uvular Lateral Approximant:

Place of Articulation	Manner of Articulation	Voiced
Dorsal	Lateral Approximant	ʟ̠

79. Alveolar Lateral Tap/Flap:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Lateral Tap/Flap	ɺ̥ | ɺ

80. Retroflex Lateral Tap/Flap:

Place of Articulation	Manner of Articulation	Voiceless/Voiced
Coronal	Lateral Tap/Flap	No Unicode/Hex?

81. Palatal Lateral Tap/Flap:

Place of Articulation	Manner of Articulation	Voiced
Coronal/Dorsal	Lateral Tap/Flap	ʎ̆

82. Velar Lateral Tap/Flap:

Place of Articulation	Manner of Articulation	Voiced
Dorsal	Lateral Tap/Flap	ʟ̆

IPA: Non-pulmonic Consonants

1. Bilabial Ejective Stop:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Labial	Ejective	Stop	p'

2. Alveolar Ejective Stop:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Coronal	Ejective	Stop	t'

3. Retroflex Ejective Stop:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Coronal	Ejective	Stop	ʈ'

4. Palatal Ejective Stop:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Coronal/Dorsal	Ejective	Stop	c'

5. Velar Ejective Stop:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Dorsal	Ejective	Stop	k'

6. Uvular Ejective Stop:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Dorsal	Ejective	Stop	q'

7. Epiglottal Ejective Stop:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant

Laryngeal	Ejective	Stop	ʡ'

8. Dental Ejective Affricate:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Coronal	Ejective	Affricate	t̪θ

9. Alveolar Ejective Affricate:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Coronal	Ejective	Affricate	ts'

10. Postalveolar Ejective Affricate:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Coronal	Ejective	Affricate	t̠ʃ

11. Retroflex Ejective Affricate:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Coronal	Ejective	Affricate	ʈʂ'

12. Velar Ejective Affricate:

Place of Articulation	Type of Articulation	Manner of Articulation	Consonant
Dorsal	Ejective	Affricate	kx'

13. Uvular Ejective Affricate:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Dorsal	Ejective	Affricate	qχ'

14. Bilabial Ejective Fricative:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Labial	Ejective	Fricative	ɸ'

15. Labiodental Ejective Fricative:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Labial	Ejective	Fricative	f'

16. Dental Ejective Fricative:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Coronal	Ejective	Fricative	ɵ'

17. Alveolar Ejective Fricative:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Coronal	Ejective	Fricative	'

18. Postalveolar Ejective Fricative:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**

Coronal	Ejective	Fricative	ʃ'

19. Palatal Ejective Fricative:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Coronal/Dorsal	Ejective	Fricative	ɕ'

20. Velar Ejective Fricative:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Dorsal	Ejective	Fricative	x'

21. Uvular Ejective Fricative:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Dorsal	Ejective	Fricative	χ'

22. Alveolar Ejective Lateral Affricate:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Coronal	Ejective	Lateral Affricate	tɬ'

23. Palatal Ejective Lateral Affricate:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Coronal/Dorsal	Ejective	Lateral Affricate	Cʎ̥˔'

24. Velar Ejective Lateral Affricate:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Dorsal	Ejective	Lateral Affricate	No Unicode/Hex?

25. Alveolar Ejective Lateral Affricate:

Place of Articulation	**Type of Articulation**	**Manner of Articulation**	**Consonant**
Coronal	Ejective	Lateral Affricate	ɬ'

26. Bilabial Click Tenuis:

Place of Articulation	**Type of Articulation**	**Velar/Uvular**
Labial	Click	kʘ | qʘ

27. Dental Click Tenuis:

Place of Articulation	**Type of Articulation**	**Velar/Uvular**
Coronal	Click	k| | q|

28. Alveolar Click Tenuis:

Place of Articulation	**Type of Articulation**	**Velar/Uvular**
Coronal	Click	k! | q!

29. Retroflex Click Tenuis:

<table>
<tr><th>Place of Articulation</th><th>Type of Articulation</th><th>Velar/Uvular</th></tr>
<tr><td>Coronal</td><td>Click</td><td>k!! | q!!</td></tr>
</table>

30. <u>Palatal Click Tenuis</u>:

<table>
<tr><th>Place of Articulation</th><th>Type of Articulation</th><th>Velar/Uvular</th></tr>
<tr><td>Coronal/Dorsal</td><td>Click</td><td>k# | q#</td></tr>
</table>

31. <u>Bilabial Click Voiced</u>:

<table>
<tr><th>Place of Articulation</th><th>Type of Articulation</th><th>Velar/Uvular</th></tr>
<tr><td>Labial</td><td>Click</td><td>gʘ | ɵʘ</td></tr>
</table>

32. <u>Dental Click Voiced</u>:

<table>
<tr><th>Place of Articulation</th><th>Type of Articulation</th><th>Velar/Uvular</th></tr>
<tr><td>Labial</td><td>Click</td><td>g| | ɢ|</td></tr>
</table>

33. <u>Alveolar Click Voiced</u>:

<table>
<tr><th>Place of Articulation</th><th>Type of Articulation</th><th>Velar/Uvular</th></tr>
<tr><td>Coronal</td><td>Click</td><td>g! | ɢ!</td></tr>
</table>

34. <u>Retroflex Click Voiced</u>:

<table>
<tr><th>Place of Articulation</th><th>Type of Articulation</th><th>Velar/Uvular</th></tr>
<tr><td>Coronal</td><td>Click</td><td>g!! | ɢ!!</td></tr>
</table>

35. Palatal Click Voiced:

Place of Articulation	**Type of Articulation**	**Velar/Uvular**
Coronal/Dorsal	Click	g# | ɢ#

36. Bilabial Click Nasal:

Place of Articulation	**Type of Articulation**	**Velar/Uvular**
Labial	Click	ŋ̥ʘ | ɴʘ

37. Dental Click Nasal:

Place of Articulation	**Type of Articulation**	**Velar/Uvular**
Coronal	Click	ŋ̥| | ɴ|

38. Alveolar Click Nasal:

Place of Articulation	**Type of Articulation**	**Velar/Uvular**
Coronal	Click	ŋ̥! | ɴ!

39. Retroflex Click Nasal:

Place of Articulation	**Type of Articulation**	**Velar/Uvular**
Coronal	Click	ŋ̥!! | ɴ!!

40. Palatal Click Nasal:

Place of Articulation	Type of Articulation	Velar/Uvular
Coronal/Dorsal	Click	ŋ̊# | ɴ#

41. <u>Velar Click Nasal</u>:

Place of Articulation	Type of Articulation	Velar
Dorsal	Click	ʞ

42. <u>Alveolar Tenuis Click Lateral</u>:

Place of Articulation	Type of Articulation	Velar/Uvular
Coronal	Click	k!! | q!!

43. <u>Alveolar Click Voiced Latera</u>:

Place of Articulation	Type of Articulation	Velar/Uvular
Labial	Click	g|| | ɢ||

44. <u>Alveolar Click Nasal Lateral</u>:

Place of Articulation	Type of Articulation	Velar/Uvular
Coronal	Click	ŋ̊|| | ɴ||

45. <u>Bilabial Implosive</u>:

Place of Articulation	Type of Articulation	Velar/Uvular
Labial	Implosive	ɓ̥ | ɓ

46. Alveolar Implosive:

Place of Articulation	Type of Articulation	Velar/Uvular
Coronal	Implosive	ɗ̥ | ɗ

47. Retroflex Implosive:

Place of Articulation	Type of Articulation	Velar/Uvular
Coronal	Implosive	ᶑ̥ | ᶑ

48. Palatal Implosive:

Place of Articulation	Type of Articulation	Velar/Uvular
Coronal/Dorsal	Implosive	ʄ̥ | ʄ

49. Velar Implosive:

Place of Articulation	Type of Articulation	Velar/Uvular
Dorsal	Implosive	ɠ̥ | ɠ

50. Uvular Implosive:

Place of Articulation	Type of Articulation	Velar/Uvular
Dorsal	Implosive	ʛ̥ | ʛ

IPA: Co-articulated Consonants

1. Labial-alveolar Nasal: n͡m
2. Labial-velar Nasal: ŋ̊͡m
3. Labial-alveolar Plosive: t͡p, d͡b
4. Labial-velar Plosive: k͡p, g͡b
5. Uvular-epiglottal Plosive: q͡ʡ
6. Labialized-palatal Approximant: ɥ̊ | ɥ
7. Labialized-velar Approximant: ʍ | w
8. Variable S_j-Sound Approximant: ɧ
9. Variable Alveolar Lateral Approximant: ɫ

Examples

1. Consonants in Ubykh and Taa: The recently extinct Ubykh language has only 2 or 3 vowels but 84 consonants (Duzemil and Esenc (1975)); the Taa language has 87 consonants under one analysis, 164 under another, plus some 30 vowels and tone (Naumann (2008)).
2. Australian Languages Lack of Fricatives: The types of consonants used in various languages is by no means universal. For instance, nearly all Australian languages lack fricatives; a large percentage of world's languages lack voiced stops such as /b/, /d/, /g/, as phonemes, though they may appear phonetically.
3. Absence of the Phonemic /n/: Most languages, however, include one or more fricatives with /s/ being the most common, and a liquid consonant or two, with /l/ being the most common.
4. Frequency of Approximants and Nasals: The approximant /w/ is also widespread, and virtually all languages have one or more nasals, though a very few, such as the central dialect

of Rotokas, lack even these. This last language has the smallest number of consonants in the world, with just six.

5. Universal Consonants around the World: The most universal consonants around the world, that is, the ones appearing in nearly all languages, are the three voiceless /p/, /t/, and /k/, and the two nasals /m/ and /n/. However, even these five are not completely universal.
6. Absence of the Phoneme /n/: The Wichita language of Oklahoma and some West African languages, such as Ijo, lack the consonant /n/ on a phonemic level, but do use it phonetically, as an allophone of another consonant - /l/ in the case of Ijo, and /ɾ/ in the case of Wichita.
7. Absence of Nasals /m/ and /n/: A few languages in the Bougainville Island and around Puget Sound, such as Makah, lack both of the nasals [m] and [n] altogether, except in special registers such as baby-talk.
8. Languages lacking /t/ and /n/: The ‘click language’ N||ng lacks /t/, and N|lu has /ts/ instead. Hawaiian is often said to lack /t/, but it actually has a consonant that varies between [t] and [k]. Colloquial Samoan lacks both alveolars /t/ and /n/. Samoan letters written with the letters t and n are pronounced as [t] and [n̥], except in formal speech. However, Samoan has another alveolar consonant, /l/.
9. /k/ in Ubykh/Adighe/Kabardian: Despite the 80-odd consonants of Ubykh, it lacks the plain velar /k/ in native words, as do the related Adighe and Kabardian languages.
10. Morphed/Transformed Versions of /k/: But with a few striking exceptions, such as Xavante and Tahitian – which have no dorsal consonants whatsoever – nearly all languages have at least one velar consonant; most of the few languages that do not have a simple /k/, that is, a sound that is generally pronounced [k], have a consonant that is very similar. For example, the Ni’ihau-Kaua’i dialect of Hawaiian is often said to have no [k], but as in other dialects of Hawaiian it has a consonant that varies between [t] and [k].
11. Morphed /k/ in PNW/Caucasus: As another example, an areal feature of the Pacific Northwest coast is that historical *k has become palatalized in many languages, so that Saanich for example has /ʧ/ and /kʷ/, but no plain /k/ (Maddieson and Disner (1984)); similarly, historical *k in Northwest Caucasian languages became palatalized to /kʲ/ in extinct Ubykh and to /ʧ/ in most Circassian dialects (Chirikba (1996)).

References

- Chirikba, V. A. (1996): *Common West Caucasian: The Reconstruction of its Phonological System and Parts of its Lexicon and Morphology* **CNWS Publishers** Leiden, Netherlands
- Duzemil, G., and T. Esenc (1975): *Le Verbe Oubykh: Etudes Descriptives et Comparitives* **Adrien Maisonnieuve** Paris, France
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Maddieson, I., and S. F. Disner (1984): *Patterns of Sounds* **Cambridge University** Cambridge, UK
- Naumann, C. (2008): The Consonantal System of West !!Xoon *3rd International Symposium on Khoisan Languages and Linguistics (Editors: Witzlack-Makarevich, A., M. Ernszt, and R. Vossen)* **Rudiger-Koppe** Riezlern, Austria
- Wikipedia (2021): Consonant

Place of Articulation

Introduction

1. Definition of Places of Articulation: In articulatory phonetics, the *place of articulation* – also *point of articulation* – of a consonant is the point of contact where an obstruction occurs in the vocal tract between an *articulatory gesture*, an active articulator – typically some part of the tongue – and a passive location, typically some part of the roof of the mouth (Wikipedia (2020)).
2. Components Causing Distinctive Consonant Sound: Along with the manner of articulation and the phonation, it gives the consonant its distinctive sound.
3. Terminology Precision across the Language Spectrum: The terminology in this chapter has been developed for precisely describing all consonants in all the world's spoken languages.
4. Relaxed Precision for a Given Language: No known language distinguishes all of the places described here so less precision is required to distinguish the sounds of a particular language.

Overview

1. Human Voice Sound Production Scheme: The human voice produces sounds in the manner described below (Titze (1994, 2008)).
2. Airflow through the Lungs: Air pressure from the lungs creates a steady flow of air through the trachea/windpipe, larynx/sound box, and pharynx or back of the throat.

3. Vocal Folds in Larynx Vibrate: The vocal folds in the larynx vibrate, creating fluctuations in air pressure, known as sound waves.
4. Vocal Tract Resonances Modifying the Sounds: Resonances in the vocal tract modify these waves according to the position and the shape of the lips, jaw, tongue, soft palate, and other speech organs, creating formant regions, and so different qualities of voiced/sonorant sound.
5. Emitting out the Sound Waves: Mouth radiates the sound waves onto the environment.
6. Injecting Nasal Quality to the Sound: Nasal cavity adds resonance to some sounds such as [m] and [n] to give nasal quality of the so-called nasal consonants.

The Larynx

1. Cartilage Anchor for Vocal Folds: The *larynx* or the *voice box* is a cylindrical framework of cartilage that serves to anchor the vocal folds.
2. Vocal Folds Contraction and Relaxation: When the muscles of the vocal folds contract, the airflow from the lungs are impeded until the vocal folds are forced apart again by increasing the air pressure from the lungs. The process continues in a periodic cycle that is felt as a vibration/buzzing.
3. Sound Pitch Produced while Singing: During singing, the vibration frequency of the vocal folds determines the pitch of the sound produced.
4. Vocal Cords determining Voiced Phonemes: Voiced phonemes such as the pure vowels are, by definition, distinguished by the buzzing sound of this periodic oscillation of the vocal cords.
5. Using Lips for Equivalent Sounds: The lips of the mouth can be used in a similar way to create a similar sound, as any toddler or trumpeter can demonstrate.
6. Example - Sound from a Stretched Balloon: A rubber balloon, inflated but not tied off and stretched tightly across the neck produces a squeak or a buzz, depending on the tension across the neck and the level of pressure inside the balloon.

7. Similarity to Actions of Vocal Cords: Similar actions with similar results occur when the vocal cords are contracted or relaxed through the larynx.

Passive Places of Articulation

1. Definition of Passive Places of Articulation: The passive place of articulation is the place on the more stationary part of the vocal tract where the articulation occurs and can be anywhere from the lips, upper teeth, gums, or the roof of the mouth to the back of the throat.
2. Passive Places of Contrast: Although it is a continuum, there are several contrastive areas so that languages my distinguish consonants by articulating them in different areas, but few languages contrast two sounds within the same area unless there is some other feature which contrasts as well.
3. Labial: The upper lip.
4. Dental: The upper teeth – either on the edge of the teeth or the inner surface.
5. Alveolar: The alveolar ridge, the gum line just behind the teeth.
6. Post-alveolar: Back of the alveolar ridge.
7. Palatal: The hard palate on the roof of the mouth.
8. Velar: The soft palate further back on the roof of the mouth.
9. Uvular: The uvula hanging down at the entrance to the throat.
10. Pharyngeal: The throat itself, a.k.a., the pharynx.
11. Epiglottal: The epiglottis at the entrance to the windpipe, above the voice box.
12. Lack of Separation among Regions: The regions are not strictly separated.
13. Denti-alveolar: For instance, in some sounds in many languages, the surface of the tongue contacts a relatively large area from the back of the upper teeth to the alveolar ridge, which is common enough to have received its own name, *denti-alveoler*.
14. Merger of Alveolar and Post-alveolar: Likewise, the alveolar and the post-alveolar regions merge into each other, as do that hard and the soft palate, the soft palate and the uvula, and all adjacent regions.

15. Pre-velar, Post-velar, Upper and Lower Pharyngeal: Terms like *pre-velar* – intermediate between the palatal and the velar, *post-velar* – between velar and uvular, and *upper* vs. *lower* pharyngeal may be used to specify more precisely where an articulation takes place.
16. Restrictions in the Combinations used: However, although a language may contrast pre-velar and post-velar sounds, it does not also contrast them with palatal and uvular sounds of the same consonant, so the contrasts are limited to the number above, if not always to the same location.

Active Places of Articulation

1. Active Places of Articulatory Gesture: The articulatory gesture of the active place of articulation involves the more mobile part of the vocal tract, typically some part of the tongue or the lip. The following areas are known to be contrastive.
2. Labial: The lower lip.
3. Coronal: Various parts of the front of the tongue.
4. Apical: Tip of the tongue.
5. Laminal: The upper front surface of the tongue just behind the tip, called the *blade* of the tongue.
6. Sub-apical: The surface of the tongue *under* the tip.
7. Dorsal: The body of the tongue.
8. Pharyngeal: The base a.k.a. the root of the tongue and the throat.
9. Aryepiglottal: The aryepiglottal fold inside the throat.
10. Glottis: The glottis at the very back of the windpipe.
11. Bilabial Joint Movement of Lips: In bilabial consonants, both lips move so the articulatory gesture brings the lips together, but by convention, the lower lip is said to be active and the upper lip passive.
12. Linguolabial - Co-movement of Tongues/Lips: Similarly, in linguolabial consonants, the tongue contacts the upper lip with upper lip actively moving down to meet the tongue;

nonetheless, the tongue is said to be active and the lip passive if for no other reason that the parts of mouth below the vocal tract are typically active, and those above the vocal tract are typically passive.

13. Dorsal Gestures and their Characteristics: In dorsal gestures, different parts of the body of the tongue contact different parts of the roof of the mouth, but it cannot be independently controlled so they are all subsumed under the term *dorsal*. That is unlike coronal gestures involving the front of the tongue, which is more flexible.
14. Epiglottal Gestures - Active or Passive: The epiglottis may be active, contacting the pharynx, or passive, being contacted by the aryepiglottal folds.
15. Complexity of Identifying Laryngeal Combinations: Distinctions made in these laryngeal areas are very difficult to observe and the subject of ongoing investigation, and several still identified combinations are thought to be possible.
16. Glottis acts upon Itself: There is sometimes fuzzy line between glottal, aryepiglottal, and epiglottal consonants and phonation, which use these same areas.
17. Distinctness among the Active Articulators: Unlike the passive articulation, which is a continuum, there are 5 distinct active articulators; the lip – *labial consonants*, the flexible front part of the tongue – *coronal consonants* – which can be laminal, apical, or sub-apical, the middle-back of the tongue – *dorsal consonants*, the root of the tongue together with the epiglottis – *pharyngeal* or *laryngeal consonants*, and the glottis – *glottal consonants*.
18. Coarticulation among the Active Articulators: The articulators are distinct in that they can act independent of each other, and two or more may work together in what is called *co-articulation* – see below.
19. Continual Nature of Coronal Articulations: The distinction, however, between various coronal articulations – apical, laminal, and sub-apical – is a continuum, without clear boundaries.

Table of Gestures and Passive Articulators and Resulting Places of Articulation

1. Active/Passive Articulator Combinations: The following table shows the possible combinations of active and passive articulators.
2. Locations for Sibilants and Non-sibilants: The possible locations for sibilants as well as non-sibilants to occur is indicated explicitly.
3. Intricacies involved in Specifying Sibilants: For sibilants, there are additional complications involving tongue shape; the chapter on sibilants contains a chart of possible articulations.
4. Bilabial:

Active Articulator Location	Front
Active Articulator Class	Labial
Active Articulator	Lower Lip (Labial)
Passive Articulator	Upper Lip
Acute/Grave	Grave
Is Sibilant?	No

5. Labiodental:

Active Articulator Location	Front
Active Articulator Class	Labial
Active Articulator	Lower Lip (Labial)
Passive Articulator	Upper Teeth
Acute/Grave	Grave
Is Sibilant?	No

6. Linguolabial:

Active Articulator Location	Front
Active Articulator Class	Coronal
Active Articulator	Tongue Blade (Laminal)
Passive Articulator	Upper Teeth
Acute/Grave	Grave
Is Sibilant?	No

7. Interdental:

Active Articulator Location	Front
Active Articulator Class	Coronal
Active Articulator	Tongue Blade (Laminal)
Passive Articulator	Upper Teeth
Acute/Grave	Acute
Is Sibilant?	Yes

8. Denti-alveolar:

Active Articulator Location	Front
Active Articulator Class	Coronal
Active Articulator	Tongue Blade (Laminal)
Passive Articulator	Upper Teeth/Alveolar Ridge
Acute/Grave	Acute
Is Sibilant?	Yes

9. <u>Laminal Alveolar</u>:

Active Articulator Location	Front
Active Articulator Class	Coronal
Active Articulator	Tongue Blade (Laminal)
Passive Articulator	Alveolar Ridge
Acute/Grave	Acute
Is Sibilant?	Yes

10. <u>Palato-alveolar</u>:

Active Articulator Location	Front
Active Articulator Class	Coronal
Active Articulator	Tongue Blade (Laminal)
Passive Articulator	Back of Alveolar Ridge (Post-alveolar)
Acute/Grave	Acute
Is Sibilant?	Yes

11. <u>Dental</u>:

Active Articulator Location	Front
Active Articulator Class	Coronal
Active Articulator	Tongue Tip (Apical)
Passive Articulator	Upper Teeth

Acute/Grave	Acute
Is Sibilant?	Yes

12. Apico-alveolar:

Active Articulator Location	Front
Active Articulator Class	Coronal
Active Articulator	Tongue Tip (Apical)
Passive Articulator	Alveolar Ridge
Acute/Grave	Acute
Is Sibilant?	Yes

13. Apical Retroflex:

Active Articulator Location	Front
Active Articulator Class	Coronal
Active Articulator	Tongue Tip (Apical)
Passive Articulator	Back of the Alveolar Ridge (Post-alveolar)
Acute/Grave	Acute
Is Sibilant?	Yes

14. Retroflex:

Active Articulator Location	Front
Active Articulator Class	Labial

Active Articulator	Underside of Tongue (sub-apical)
Passive Articulator	Hard Palate (front)
Acute/Grave	Acute
Is Sibilant?	Yes

15. Alveolo-Palatal:

Active Articulator Location	Back
Active Articulator Class	Guttural
Active Articulator	Tongue Body (Dorsal)
Passive Articulator	Back of Alveolar Ridge (Post-alveolar)
Acute/Grave	Acute
Is Sibilant?	Yes

16. Palatal:

Active Articulator Location	Back
Active Articulator Class	Guttural
Active Articulator	Tongue Body (Dorsal)
Passive Articulator	Hard Palate (Front)
Acute/Grave	Acute
Is Sibilant?	No

17. Velar:

Active Articulator Location	Back
Active Articulator Class	Guttural
Active Articulator	Tongue Body (Dorsal)
Passive Articulator	Soft Palate
Acute/Grave	Grave
Is Sibilant?	No

18. Uvular:

Active Articulator Location	Back
Active Articulator Class	Guttural
Active Articulator	Tongue Body (Dorsal)
Passive Articulator	Uvula
Acute/Grave	Grave
Is Sibilant?	No

19. Pharyngeal:

Active Articulator Location	Back
Active Articulator Class	Guttural
Active Articulator	Tongue Root (Radical)
Passive Articulator	Pharynx
Acute/Grave	Grave
Is Sibilant?	No

20. Epiglotto-Pharyngeal:

Active Articulator Location	Back
Active Articulator Class	Guttural
Active Articulator	Larynx (Laryngeal)
Passive Articulator	Pharynx
Acute/Grave	Grave
Is Sibilant?	No

21. (Ary-)Epiglottal:

Active Articulator Location	Back
Active Articulator Class	Guttural
Active Articulator	Larynx (Laryngeal)
Passive Articulator	Epiglotto-Pharyngeal
Acute/Grave	Grave
Is Sibilant?	No

22. Glottal:

Active Articulator Location	Back
Active Articulator Class	Guttural
Active Articulator	Larynx (Laryngeal)
Passive Articulator	Glottis

Acute/Grave	Grave
Is Sibilant?	No

23. Active/Passive Articulator Combination Terms: A precise vocabulary for compounding the two places of articulation is sometimes seen.
24. Reduction to Passive Articulator References: However, it is usually reduced to the passive articulation, which is generally sufficient. Thus, *dorsal-palatal*, *dorsal-velar*, and *dorsal-uvular* are usually just called palatal, velar, and uvular.
25. Specialized Terms for Custom Combinations: To resolve ambiguity additional terms have been invented, so *subapical-palatal* is more commonly called *retroflex*.
26. Specificity for the Passive Articulator: Additional shades of passive articulation are sometimes specified using *pre*- or *post*-, for example *pre-palatal* – near the border between post-alveolar region and the hard palate; *pre-velar* at the back of the hard palate; also, *post-palatal* or even *medio-palatal* for the middle of the hard palate; or *post-velar* near the border of the soft-palate and the uvula.
27. IPA Symbology for Passive Regions: They can be useful in he precise description of sounds that are articulated somewhat farther or back than a prototypical consonant; for this purpose, the *fronted* and the *retracted* IPA diacritics are used.
28. Distinguishing Consonants of a Language: However, no additional shade is needed to phonemically distinguish two consonants in a single language.
29. Multi-shaded Passive Articulation Consonants: Occasionally, claims to the contrary are met. For example, some dialects in Malayalam are said to distinguish palatal, pre-velar, and velar consonants. In reality, the dialects distinguish palato-alveolar – palatized post-alveolar – palatal, and velar consonants; the claim is based on the imprecise usage of *palatal* to mean *palato-alveolar*.

Homorganic Consonants

1. Consonants with Same Places of Articulation: Consonants that have the same place of articulation, such as the alveolar sounds /n, t, d, s, z, l/ in English, are said to be *homorganic*. Similarly, labial /p, b, m/ and velar /k, g, n,/ are homorganic.
2. Homorganic Nasal Consonant Rule: A homorganic nasal rule, an instance of assimilation, operates in many languages, where a nasal consonant must be homorganic with a following stop.
3. Homorganic Nasal Assimilation Examples: This is seen in English *i**n**tolerable* but *i**m**plausible*; another example is found in Yoruba, where the present tense of *ba* "hide" is *mba* "is hiding", while the present tense of *sun* "sleep" is *nsun* "is sleeping".

Central and Lateral Articulation

1. Dimensions where Tongue contacts Mouth: The tongue contacts the mouth with a surface that has two dimensions – length and width.
2. Articulation/Variation along Length/Width: So far, only points of articulation along its length have been considered. However, articulation varies along its width as well.
3. Central Consonant - Straight-down Airstream Draft: When the airstream is directed down the center of the tongue, the consonant is said to be *central*.
4. Lateral Consonant - Sideways Airstream Deflection: If, however, it is deflected off to one side, escaping between the side of the tongue and the side teeth, it is said to be *lateral*.
5. Fully Specified Place of Articulation: Nonetheless, for simplicity's sake, the place of articulation is assumed to be the point along the length of the tongue, and the consonant in addition may said to be central or lateral.
6. Example - Lateral Alveolar or Palatal: That is, a consonant may be lateral alveolar, like the English /l/ - here the tongue contacts the alveolar ridge, but allows air to flow off to the side – or lateral palatal like the Castilian Spanish ll <inverted y>.

7. Indigenous Australian/Native American Laterals: Some indigenous Australian languages contrast dental, alveolar, retroflex, and palatal laterals, and many Native American languages have lateral fricatives and affricates as well.

Coarticulation

1. Two Simultaneous Places of Articulation: Some languages have consonants with two places of articulation, which is called co-articulation.
2. Independent Motion of Double Articulators: When these are doubly articulated, the articulators must be independently moveable, and therefore, there may be only one each from the major categories - *labial*, *coronal*, *dorsal*, and *pharyngeal*.
3. Labial Velar Stops of West Central Africa: The only common doubly articulated are labial-velar stops like [k/p super-cap], [g/b super cap], and less commonly [(n sub j)/m super cap], which are found throughout Western Africa and Central Africa.
4. Labial-Postalveolar and Uvular-Epiglottal Stops: Other combinations are rare but include labial-postalveolar stops [t/p super cap, d/b super cap, n/m super cap], found as distinct consonants only in a single language in New Guinea, and a uvular-epiglottal stop [q/?hash super cap] found in Somali.
5. Approximant Secondary Articulators: More commonly, coarticulation involves secondary articulation of an approximant nature. Then, both articulations can be similar such as labialized labial [m super w] or palatalized velar [k super j]. That is the case with English [w], which is a velar consonant with secondary label articulation.
6. Labialization: Common coarticulations include *labialization*, rounding the lips while producing the obstruction, as in [k super w] and English [w].
7. Palatalization: Raising the body of the tongue toward the hard palate while producing the obstruction, as in Russian [t sup j] and [stem extended e].
8. Velarization: Raising the back of the tongue toward the soft palate – velum – as in English dark, el [l super (v sub angstrom degree)] – also transcribed [extended t].

9. Pharyngealization: Constriction of the throat – pharynx, such as Arabic “emphatic” [t sup unwritable].

References

- Titze, I. R. (1994): *Principles of Voice Production* **Prentice Hall** Hoboken, NJ
- Titze, I. R. (2008): The Human Instrument *Scientific American* **298 (1)** 94-101
- Wikipedia (2020): Place of Articulation

Labial Consonant

Overview

1. Lip Articulation – Bilabials and Labiodentals: *Labial consonants* are the consonants in which one or both lips are the active articulators. The two common labial articulations are bilabials, articulated using both lips, and labiodentals, articulated with the lower lip against the upper teeth, both of which are present in English.
2. Dento-labials - Upper Lip/Lower Teeth: A third labial articulation is the dentolabials, articulated with the upper lip against the lower teeth – the reverse of labiodental, normally only found in pathological speech.
3. Linguolabials - Upper Lip/Tongue Tip: Generally precluded are linguolabials, in which the tip of the tongue contacts the posterior side of the upper lip, making them coronals, though sometimes they behave as labial consonants.
4. Bilabials and Labiodentals in English: The most common distribution between the bilabials and the labiodentals is the English one, in which the nasal and the stops – [m], [p], and [b] – are bilabial, and the fricatives – [f] and [v] – are labiodental.
5. Voiced/Voiceless Bilabial Fricative Approximant: The voiceless bilabial fricative, the voiced bilabial fricative, and the bilabial approximant do not exist in English, but they occur in many languages. For example, the Spanish consonant written *b* or *v* is pronounced, between vowels, as a voice bilabial approximant.
6. Labialization - Coarticulation using Rounded Lips: Lip-rounding, or labialization, is a common approximant-like coarticulation feature. English /w/ is a voiced velarized labial approximant, which is far more common that the purely labial approximant [β_T]. In the languages of Caucasus, labialized dorsals like /k^w/ and /q^w/ are very common.

7. Constituents of the Labial Category: Very few languages, however, make a distinction purely between bilabials and labiodentals, making *labials* usually a sufficient specification of a language's phonemes. One exception is Ewe, which has both kinds of fricatives, but the labiodentals are produced with a greater articulatory force.

Absence of Labials

1. Languages that Lack Labials Entirely: While most languages make use of purely labial phonemes, a few generally lack them. Examples are Tlingit and Eyak – both Na-Dene', Wichita – Caddoan, and the Iroquoian languages except Cherokee.
2. Transcribing Labialization in these Languages: Many of these languages are transcribed with a /w/ and with labialized consonants. However, it is not always clear as to what extent the lips are involved in such sounds.
3. Example Labialization in Iroquoian Languages: In the Iroquoian languages, for example, /w/ involved little apparent rounding of the lips. As an instance, the Tillamook language has *rounded* consonants and vowels that do not have any actual bilabialization. All of these languages have seen labials introduced under the influence of English.

References

- Wikipedia (2021): Labial Consonant

Coronal Consonant

Overview

1. <u>Front of the Tongue Articulation</u>: *Coronal consonants* are consonants articulated with the flexible front part of the tongue (Wikipedia (2021)).
2. <u>Wide Range of Coronal Articulations</u>: Among places of articulation, only the coronal consonants can be divided into as many articulation types: apical – using the tip of the tongue, laminal – using the blade of the tongue, domed – with the tongue bunched up, or subapical – using the underside of the tongue, as well as different postalveolar articulations – some of which also involve the back of the tongue as an articulator – palato-alveolar, alveolo-palatal, and retroflex.
3. <u>Versatility of the Tongue Front</u>: Only the front part of the tongue, i.e., coronal, has such dexterity across the major places of articulation, allowing such variety of distinctions. Coronals have another dimension – grooved – to make sibilants in combination with the orientations above.

Places of Articulation

1. <u>Dental, Alveolar, Postalveolar, and Retroflex</u>: Coronal places of articulation include the dental consonants at the upper teeth, the alveolar consonants at the upper gum – the alveolar ridge, the various postalveolar consonants – including domed palate-alveolar, laminal alveolo-palatal, and apical retroflex. Just behind that are the subapical retroflex consonants

curled back against the hard palate, and linguolabial consonants with the tongue against the upper lip. Alveolo-palatal and linguolabial consonants sometimes behave as dorsal and labial consonants, respectively, rather than as coronals.

2. Coronal Sibilants:

		IPA Symbol	Meaning
Place of Articulation	**Passive (Mouth)**		Dental
			Advanced (Denti-alveolar)
			Alveolar
			Retracted (Post-alveolar)
	Active (Tongue)		Apical
			Laminal
			Retroflex
	Secondary		Palatalized Coronal
			Alveolo-palatal
			Palato-alveolar
			Labialized Coronal
			Velarized Coronal
			Pharyngealized Coronal
Voice Onset Time			Aspirated Coronal

Examples

In Arabic and Maltese philology, the run letters represent coronal consonants.

European Coronal Consonants

IPA Symbol	Name of the Consonant	Language	Example	IPA
	Voice Alveolar Sibilant		***z****oo*	
	Voiceless Alveolar Sibilant		***s****ea*	
	Voiced Dental Fricative		***th****at*	
	Voiceless Dental Fricative		***th****ud*	
	Voiced Palato-alveolar Fricative		*vi****si****on*	
	Voiceless Palato-alveolar Fricative	English	***she***	
	Alveolar Nasal		***n****ame*	
	Voiced Alveolar Plosive		***d****ay*	
	Voiceless Alveolar Plosive		***t****ea*	
	Alveolar Approximant		***r****eef*	
	Alveolar Lateral Approximant		***l****ift*	
	Alveolar Trill	Spanish	*pe****rr****o*	
	Alveolar Flap		*Pe****r****o*	

Australian Aboriginal Coronal Consonants

1. Coronal Contrast with Peripheral Consonants: In Australian Aboriginal languages, coronals contrast with peripheral consonants.
2. Australian Coronal Consonants (Dixon (2002)):

	Laminal		**Apical**	
	Alveolo-palatal	**Dental**	**Alveolar**	**Retroflex**
Stop			t	
Nasal			n	
Lateral			l	

References

- Dixon, R. M. W. (2002): *Australian Languages: Their Nature and Development* **Cambridge University Press** Cambridge, UK
- Wikipedia (2021): Coronal Consonant

Palatal Consonants

Overview

Palatal consonants are consonants articulated with the body of the tongue raised against the hard palate – the middle part of the roof of the mouth (Wikipedia (2002)).

Characteristics

1. Common Types of Palatal Consonants: The most common type of palatal consonant is the extremely common approximant [j], which ranks among the 10 most common sounds in the world's languages. The nasal [,n] is also common, occurring in about 35 percent of the world's languages (Maddieson (1984)), in most of which its equivalent obstruent is not the stop [c], but the affricate [t integral super cap].
2. Palatal Stops vs. Post-alveolar Affricates: Only a few languages in northern Eurasia, the Americas, and central Africa contrast palatal stops with post-alveolar affricates -as in Hungarian, Czech, Latvian, Macedonian, Slovak, Turkish, and Albanian.
3. Palatalization - Primary vs. Secondary Articulation: Consonants with other primary articulation may be *palatalized*, that is, accompanied by the raising of the tongue surface towards the hard palate. For example, the English [integral] – spelled *sh* – has such a palatal component, although its primary articulation involves the tip of the tongue and the upper gum – this type of articulation is called palate-alveolar.

4. Lack of Contrast with Palatals: In phonology, alveolo-palatal, palate-alveolar, and and palate-velar consonants are commonly grouped as palatals, since these categories rarely contrast with pure palatals. Sometimes palatalized alveolars or dentals can be analyzed in this manner as well.

Distinction from Palatalized Consonants and Consonant Clusters

1. Palatals vs. Palatalization/Consonant Clusters: Palatal consonants can be distinguished from palatalized consonants and consonant clusters of a consonant and the palatal approximant [j]. Palatal consonants have their primary articulation toward or in contact with the hard palate, whereas palatalized consonants have a primary articulation in some other area and a secondary articulation involving movement towards the hard palate.
2. Phonemic Distinctness in Consonant Clusters: Palatal and palatalized consonants are both single phonemes, whereas the sequence of a consonant and [j] contains two phonemes.
3. Palatal Variations in Traditional Irish: Irish distinguishes the palatal nasal /,n/ from the palatalized alveolar nasal /n^j/. In fact, some conservative Irish dialects have two palatalized alveolar nasals, distinguished as *fortis* – apical and somewhat lengthened, vs. *lenis* – laminal.
4. Spanish - Explicit Distinction of Palatals #1: Spanish marginally distinguished palatal consonants from sequences of a dental and the palatal approximant:
    a. *un~o'n* => /u,non/ "large nail"
    b. *unio'n* => /unjon/ "union"
5. Interchanging the Terms Palatal/Palatalized: Sometimes the *palatal* is used imprecisely to mean *palatalized*.
6. Coarticulation of Palatals in English: Also, languages that have sequence of consonants and /j/, but no palatal r palatalized consonants, e.g., English, will often pronounce a sequence with /j/ as a single palatal or palatalized consonant. This is due to the principle of least effort and is an example of the general phenomenon of coarticulation.

7. Spanish - Explicit Distinction of Palatals #2: On the other hand, Spanish speakers can be careful to pronounce /nj/ as two separate sounds to avoid possible confusion with /,n/.

Examples

IPA	Description	Example			
		Language	**Orthography**	**IPA**	**Meaning**
	Palatal Nasal	Malay			many
	Voiceless Palatal Plosive	Hungarian			swan
	Voiced Palatal Plosive	Latvian			family
	Voiceless Palatal Fricative	German			not
	Voiced Palatal Fricative	Spanish			lightning bolt
	Palatal Approximant	English			
	Palatal Lateral Approximant	Italian			the (masculine plural)
	Voiced Palatal Implosive	Swahili			hello
	Palatal Click Release (Many Distinct Consonants)	N||ng			man, male

References

- Maddieson, I. (1984): *Patterns of Sounds* **Cambridge University Press** Cambridge, UK

- Wikipedia (2021): Palatal Consonant

Palatalization

Overview

1. Process of Palatalizing a Consonant: *Palatalization* or *palatization* refers to the way of pronouncing a consonant in which part of the tongue is moved close to the hard palate. Consonants pronounced this way are said to be *palatalized* and are transcribed in the IPA by affixing the letter <ʲ> to the base consonant (Wikipedia (2020)).
2. Palatalization Based Contrast across Languages: Palatalization cannot minimally distinguish most dialects of English, but it may do so in languages such as Russian, Mandarin, and Irish.
3. Encoding:

Symbol	ʲ
IPA Number	421
Entity Decimal	ʲ
Unicode Hex	U+02B2

Types

1. Tongue Raised Toward Hard Palate: In technical terms, palatalization refers to the secondary articulation of the consonants by which the body of the tongue is raised toward the hard palate and the alveolar ridge during the articulation of the consonant. Such consonants are phonetically palatalized.

2. Idea behind *Pure* Palatalization: *Pure* palatalization is a modification to the articulation of a consonant, where the middle of the tongue is raised, and nothing else. It may produce a laminal articulation of otherwise apical consonants such as /t/ and /s/.
3. Adding Semivowel Onglides and Offglides: Phonetically palatalized consonants may vary in their exact realization. Some languages may add semivowels before or after the palatalized consonants, i.e., onglides and offglides.
4. Russian Example - Palatal, Vowel Onglide: In Russian, both plain and palatalized consonant phonemes are found. Typically, the vowel – especially a non-front vowel – following a palatalized consonant has a palatal onglide.
5. Onglides and Offglides in Hupa: In Hupa, on the other hand, palatalization is heard as both an onglide and an offglide.
6. Palatalization without Corresponding Phonemic Change: In some cases, the realization of palatalization may occur without any corresponding phonemic change. For example, palatalized consonants at the end of a syllable in Old Irish had a corresponding onglide – reflected as <i> in the spelling, which was no longer present in Middle Irish, based on explicit testimonies of the grammarians of the time.
7. Palatalization as a Suprasegmental Feature: In a few languages like Skolt Sami and many of the Central Chadic languages, palatalization is a suprasegmental feature that affects the pronunciation of the entire syllable, and it may certain vowels to be pronounced more front and consonants to be slightly palatalized. In Skolt Sami and its relatives – Kildin Sami and Ter Sami – suprasegmental palatalization contrasts with segmental palatal articulation, i.e., palatal consonants.

Transcription

1. IPA Transcription of Palatalized Consonants: In IPA, palatalized consonants are marked by the modifier letter <^{j}>, a superscript version of the symbol for the palatal approximant <j>. For instance, <t^j> represents the palatalized form of the voiceless alveolar stop [t].

2. Previous Representation of Palatalized Consonants: Prior to 1989, a subscript diacritic <b, c, d, f, g, h, l, m, n, p, r, s, t, v, x, z,> was used, and several palatalized consonants were represented by curly-tailed variants in the IPA, e.g., <integral curly tail> for [integral super j] and <z curly tail> for <z super j>.
3. Palatalization in Uralic Phonetic Alphabet: The Uralic Phonetic Alphabet marks palatalized consonants by an acute accent, as do some Finnic languages using the Latin alphabet, as in Vo~ro <s'>. Others use an apostrophe, as in Karelian <s'>; or digraphs in j, as in the Savonian dialects of Finnish, <sj>.

Phonology

Palatalization has varying phonological significance in various languages. It is allophonic in English, but phonemic in others. In English, consonants are palatalized when they occur before the front vowel or the palatal approximant, and no words are distinguished by palatalization, but in other languages palatalized consonants appear in the same environment, i.e., contrastive distribution, as plain consonants and distinguish words.

Allophonic

1. Allophonic Nature of Consonant Palatalization: In some languages, palatalization is allophonic. Some phonemes have palatalized allophones in certain contexts, typically before from vowels, and unpalatalized allophones occur elsewhere. Because it is allophonic, palatalization of this type does not distinguish words and often goes unnoticed by native speakers.

2. Phonetic Palatalization in American English: In American English, stops are palatalized before the front vowel /i/ and not palatalized in other cases.

Phonemic

1. Phonemic Nature of Consonant Palatalization: In some languages, palatalization is a distinctive feature that distinguishes two consonant phonemes. This feature occurs in Russian, Irish, and Scottish Gaelic.
2. Contrast against Plain/Velarized Articulation: Phonemic palatalization may be contrasted with either plain or velarized articulation. In many of the Slavic languages, and some of the Baltic and Finnic languages, palatalized consonants contrast with plain consonants, but in Irish they contrast with velarized consonants.
3. Example - Phonemic Palatalization in Russian:
   - HOC /nos/ "nose" – unpalatalized /n/
   - He (double dot) c /n^jos/ "he carried" – palatalized /n^j/
4. Example - Phonemic Palatalization in Irish:
   - *bo'* /b (super (v above degree)) o:/ "cow" – velarized *b*
   - *beo* /b^jo:/ "alive" – palatalized *b*
5. Shifts in Primary Places of Articulation: Some palatalized phonemes undergo changes beyond phonetic palatalization. For example, the unpalatalized sibilant – Irish /s (super v above degree)/, Scottish /s (above downward dome)/ - has a palatalized counterpart that is actually postalveolar /integral/, not the phonetically palatalized [s^j], and the velar fricative /x/ in both languages has a palatalized counterpart that is actually /c,/ rather than palatalized velar [x^j]. These shifts in the primary place of articulation are examples of sound change in palatalization.

Morphophonemic

1. Palatalization as Part of Morpheme: In some languages, palatalization is used as a morpheme or part of the morpheme. In some cases, the vowel caused a consonant to become palatalized, and then this vowel was lost by elision. Here, there appears to be a phonemic contrast when analysis of the deep structure shows it to be allophonic.
2. Romanian Example - Palatalization of Plurals: In Romanian, consonants are palatalized before /i/. Palatalized consonants appear at the end of the word, and mark the plural in nouns and adjectives, and the second person singular in verbs (Chitoran (2001)). On the surface, it would appear that *ban* [ban] "coin" forms a minimal pair with *bani* [ban^j]. The interpretation commonly taken, however, is that an underlying morpheme /-1/ palatalized the consonant and is subsequently deleted.
3. Alternation as a Consequence of Palatalization: Palatalization may also occur as a morphological feature. For example, although Russian makes phonemic contrasts between palatalized and unpalatalized consonants, alternations across morpheme boundaries are normal (Lightner (1972)).

Sound Changes

1. Phonemic Palatalization and Articulatory Shifts: In some languages, allophonic palatalization developed into phonemic palatalization by phonemic split. In other languages, phonemes that were phonetically palatalized changed further: palatal secondary places of articulation developed into changes in either manner of articulation or primary place of articulation.

Example – Slavic Languages

In Slavic languages, palatal or palatalized consonants are called *soft*, and others are called *hard*. Russian hairs pairs of palatalized and unpalatalized phonemes. The vowel letters <e>, <e (two dots above)>, <(cross I) O>, <transposed R>, and <transposed N> indicate that the consonant preceding them is soft. The soft sign <b> also indicates that the previous consonant is soft.

Example – Goidelic

Irish and Scottish Gaelic have pairs of palatalized – *slender* – and unpalatalized - *broad* – phonemes. In Irish, most broad consonants are velarized. In Scottish Gaelic, the only velarized consonants are [(n above dome) super (v above degree)] and [(l above dome) super (v above degree)]; [r] is sometimes described as velarized as well (Bauer (2011, Nance, McLeod, O'Rourke, and Dunmore (2016)).

Example – Mandarin Chinese

Palatalized consonants occur in standard Mandarin Chinese in the form of alveolo-palatal consonants, which are written in pinyin as *j*, *q*, and *x*.

Example – Marshallese

In the Marshallese language, each consonant has come type of secondary articulation – palatalization, velarization, and labialization. The palatalized consonants are regarded as *light*, and the velarized and the rounded consonants are regarded as *heavy*, with the rounded consonants being both velarized and labialized.

Other Uses

1. <u>Local/Historical Uses of Palatalization</u>: There are local and historical uses of the term *palatalization*.
2. <u>Usage/Meaning in Slavic Languages</u>: In Slavic linguistics, the *palatal* fricatives marked by a hacek are really postalveolar consonants, which historically arose from palatalization. There are also phonetically palatalized consonants, marked with an acute accent, which contrast with that. Thus, a distinction is made between *palatal* – which is really postalveolar – and *palatalized*. Such *palatalized* consonants are not always phonetically palatalized. For example, when Russian *soft* consonants appear before the front vowels – particularly [i] – they are not palatalized and contrast with the *hard* consonants – which are typically not palatalized, but are velarized in the same context.
3. <u>Usage/Meaning in Uralic Languages</u>: In Uralic linguistics, palatalization has the same phonetic meaning - /s/, /s^j/, /integral/, /t/, and /t integral/ are distinct phonemes – as in Slavic languages, but /t/ and /t integral/ are not considered either palatal or palatalized sounds. Also, the Uralic palatalized /t^j/, unlike in Russian, is a stop with no friction.

References

- Bauer, N. (2011): *Blas na Gaidhlig: The Practical Guide to Gaelic Pronunciation* **Akerbeltz** Glasgow, UK
- Chitoran, I. (2001): *The Phonology of Romanian: A Constraint-based Approach* **Mouton de Gruyter** New York, NY
- Lightner, T. M. (1972): *Problems in the Theory of Phonology, I: Russian Phonology and Turkish Phonology* **Linguistic Research Inc.** Edmonton, AB
- Nance, C., W. McLeod, B. O'Rourke, and S. Dunmore (2016): Identity, Accent Aim, and Motivation in Second Language Users: New Scottish Gaelic Speakers' Use of Phonetic Variation *Journal of Sociolinguistics* **20 (2)** 164-191
- Wikipedia (2020): Palatalization

Post-alveolar Consonant

Overview

1. Postalveolar Consonants Places of Articulation: *Postalveolar* or *post-alveolar* consonants are articulated with the tongue near or touching the back of the alveolar ridge. Articulation is farther back in the mouth than alveolar consonants, which occur at the ridge itself, but not as far back as the hard palate, the place of articulation for palatal consonants. Examples of post-alveolar consonants are the English palate-alveolar consonants [integral], with [t integral], [Z weird], and [d Z weird], as in the words **sh**ip, **ch**ill, vi**s**ion, and **j**ump, respectively (Wikipedia (2021)).
2. Types of Postalveolar Consonants: There are many types of post-alveolar sounds, especially among sibilants. The three primary types are *palato-alveolar* such as [integral Z weird] which are weakly palatalized, *alveolo-palatal* such as [c left tail z left tail] which are strongly palatalized, and retroflex such as [,s ,z] which are unpalatalized. The palate-alveolar and the alveolo-palatal subtypes are commonly counted as *palatals* in phonology, since they rarely contrast with true palatal consonants.

Post-alveolar Sibilants

1. Specifying the Place of Articulation: For most sounds involving the tongue, the place of articulation can be sufficiently identified by specifying the point of contact on the upper part of the mouth – for example, the velar consonants involve contact on the soft palate and the

dental consonants involve the teeth, along with any secondary articulation such as palatalization – raising of the tongue body, or labialization or lip rounding.

2. Tongue Shape Impact on Sibilants: However, among sibilants, there are slight differences in the shape of the tongue and the point of contact on the tongue itself, which correspond to large differences in the resulting sound.
3. Sound Quality of Alveolar Sibilants: For example, the alveolar fricative [s] and the three post-alveolar fricatives [left tail e integral ,s] differ noticeably in pitch and sharpness, the order [s left tail e integral ,s] corresponds to progressively lower-pitched and duller, i.e., less "hissing" or piercing, sounds.
4. Specifying Pitch Grade in Sibilants: [s] is the highest pitch and the most piercing, which is the reason that hissing sounds like "Sssst!" or "Psssst!" are used to attract someone's attention. As a result, it is necessary to specify many additional subtypes.

Tongue Shape

1. Tongue Shape Indicating Palatalization Degree: The main distinction is the shape of the tongue, which corresponds to differing degrees of palatalization, by raising the front of the tongue. The increasing palatalization corresponds to progressively higher-pitched and sharper-sounding consonants.
2. Pronunciation Guide for Retroflex Consonants: Less technically, the retroflex consonant [,s] sounds somewhat like a mixture between the regular English [integral] of "ship" and the "h" at the beginning of "heard", especially when it is pronounced forcefully and with a strong American "r".
3. Pronunciation Guide for Alveolopalatal Consonants: The alveolopalatal consonant [left tail e] sounds like a strongly palatalized version of [integral], somewhat like "nourish you".
4. Tongue Shape for Palato-alveolar Sounds: Palato-alveolar sounds are normally described as having a convex, i.e., bunched-up or domed, *tongue*. The front, central part of the tongue is

somewhat raised compared to the tip, the back, and the sides, which gives it a weak palatalization.

5. <u>Tongue Shape for Retroflex Sounds</u>: For retroflex sounds, the tongue shape is either concave – usually with apical or sub-apical, made with the tip of the tongue, or flat – usually laminal, made with the area behind the tongue.
6. <u>Tongue Shape for Alveolopalatal Sounds</u>: For alveolopalatal sounds, the front part of the tongue is flat and raised so that it closely parallels the upper surface of the mouth, from teeth to the hard palate. Behind that is a sudden convex bend.
7. <u>IPA Transcription of Postalveolar Sibilants</u>:

IPA	Description	Language	Orthography	IPA	Meaning
	Voiceless Palatoalveolar Sibilant	English	**sh**in		shin
	Voiceless Alveolopalatal Sibilant	Mandarin			small
	Voiceless Retroflex Sibilant	Mandarin			Shanghai
	Voiced Palatoalveolar Sibilant	English	vi**si**on		vision
	Voiced Alveolopalatal Sibilant	Polish			herb
	Voiced Retroflex Sibilant	Russian Polish			toad frog

Point of Tongue Contact (Laminal, Apical, and Subapical)

1. <u>Location Descriptions of Tongue Contacts</u>: The second variable is whether the contact occurs with the very tip of the tongue – an *apical* articulation [integral] – with the surface just above the tip, the *blade* of the tongue – a *laminal* articulation [integral over degree], or with the underside of the tip – a *subapical* articulation.

2. Tongue-Up Apical vs. Tongue-Down Laminal: Apical and subapical articulations are always "tongue-up", with the tip of the tongue above the teeth, and laminal articulations are always "tongue-down", with the tip of the tongue behind the lower teeth.
3. Palatalization Issues with Apical/Laminal: The upward curvature of the tongue tip to make apical or subapical contact renders palatalization more difficult, so domed, i.e., palatoalveolar consonants are not attested with subapical articulation, and fully palatalized – such as alveolopalatal – occur only with laminal palatalization.
4. Apical/Laminal Distinction among Palatoalveolar: Also, the apical/laminal distinction among palatoalveolar sounds makes little – although presumably non-zero – perceptible difference; both articulations, in fact, occur among English speakers (Ladefoged and Maddieson (1996)).
5. Postalveolar Sibilants Distinction - Toda Language: The Toda language consistently uses a laminal articulation for its palatoalveolar sibilants, which presumably makes the sound a bit sharper, more like the alveolopalatal sibilants, increasing the perceptual difference from the two types of retroflex sibilants that also occur in Toda.
6. Tongue Impact on Retroflex Consonants: As a result, different points of the tongue contact – laminal, apical, and subapical – are significant largely for retroflex sounds.
7. Retroflex Sounds - Upper Jaw Range: Retroflex sounds can also occur outside of the postalveolar region, ranging from as far back as the hard palate to as far forward as the alveolar region behind the teeth.
8. Palatal Tendency of Subapical Languages: Subapical retroflex sounds are often palatal – and vice versa, which occur particularly in Dravidian languages.

Position of the Tongue Tip – Laminal "Closed"

1. Tongue-down Laminal – Additional Specification: There is an additional distinction that can be made among tongue-down laminal sounds, depending on where exactly behind the lower teeth the tongue tip is placed. A bit behind the lower teeth is the hollow area – or pit – in the lower surface of the mouth.

2. Sublingual Cavity below the Tongue: When the tongue tip rests in the hollowed area, there is an empty space below the tongue – a *sublingual cavity* – which results in a relatively more "hushing" sound. When the tip of the tongue rests against the lower teeth, there is no sublingual cavity, resulting in a more "hissing" sound.
3. Tongue-down Alveolar/Postalveolar Consonants: Generally, the tongue-down postalveolar consonants have the tongue tip on the hollowed area, i.e., with a sublingual cavity, whereas for the tongue-down alveolar consonants, the tongue tip rests against the teeth, i.e., no sublingual cavity, which accentuates the hissing vs. the hushing distinction of these sounds.
4. Exception in Northwest Caucasian Languages: However, the palatoalveolar sibilants in Northwest Caucasian languages such as the extinct Ubykh have the tongue tip resting directly against the lower teeth rather than on the hollowed area. Ladefoged and Maddieson (1996) term it as a "*closed* laminal postalveolar" articulation, which gives the sounds a quality that Catford describes as "hushing-hissing". Catford transcribes them as <s above hat, z above hat> - this is not the IPA notation; the obsolete IPA letters <left tail integral, left tail z> have occasionally been resurrected for these sounds.
5. Closed vs. Non-closed Sibilant Articulation: A laminal "closed" articulation could also be made with alveolopalatal sibilants and a laminal "non-closed" articulation with alveolar sibilants, but no language appears to do so.
6. Minimal Contrast across these Articulators: In addition, no language seems to have a minimal contrast between these two sounds based only on the "closed"/"non-closed" variation, with no accompanying articulatory distinctions. More specifically, for all languages including the Northwest Caucasian languages, if the language has two laminal sibilants, one of which is closed and the other is non-closed, they will also differ in other ways.

Examples

1. Distinction between Three Postalveolar Sibilants: A few languages distinguish between three postalveolar tongue shapes - /,s/ /integral/ /left tail e/ - such as Sino-Tibetan Northern Qiang and Southern Qiang, which make such a distinction among affricates – but only a two-way distinction among fricatives – and the Northwest Caucasian languages Ubykh and Abkhaz.
2. Distinction between Two Postalveolar Sibilants: More common are languages such as Mandarin Chinese and Polish, which distinguish two palatoalveolar sibilants, typically /,s/ and /left tail e/ since they are maximally distinct.
3. Notation in Examples - Note #1: The attested possibilities, with exemplar languages, are as follows. IPA diacritics are simplified, and some articulations would require two diacritics to be fully specified, but only one is used to keep the results legible without the need for OpenType IPA fonts.
4. Notation in Examples - Note #2: Also, Peter Ladefoged, whose notation is used here, has resurrected an obsolete IPA symbol, the under dot, to indicate the apical postalveolar, which is normally included in the category of retroflex consonants.
5. Notation in Examples - Note #3: The notation $\underline{s}, s\ above\ dot$ is sometimes reversed, and either may be called ‘retroflex’ and written /,s/.
6. Laminal Flat Postalveolar - Laminal Retroflex:

IPA	
Example Languages	Polish *sz, cz, rz, dz dot*, Mandarin *sh, zh, ch*

7. Apical Postalveolar - Apical Retroflex:

IPA	
Example Languages	Ubykh, Toda

8. Domed Postalveolar - Palatoalveolar:

IPA	

Example Languages	English *sh, zh* – may be either apical or laminal

9. <u>Laminal Domed Postalveolar</u>:

IPA	
Example Languages	Toda

10. <u>Laminal Palatalized Postalveolar - Alveolopalatal</u>:

IPA	
Example Languages	Mandarin *q, j, x* Polish (please transcribe from notes), Ubykh

11. <u>Laminal Closed Postalveolar</u>:

IPA	
Example Languages	Ubykh

12. <u>Subapical Postalveolar or Palatal - Subapical Retroflex</u>:

IPA	
Example Languages	Toda

Postalveolar Non-sibilants

1. Reduction in Acoustically Distinct Variations: Non-sibilant sounds can also be made in the post-alveolar region; however, the number of acoustically distinct variations is then significantly reduced.
2. Laminal Palatalized vs. Apical Retroflex: The primary distinction for such sounds is laminal palatalized and apical retroflex non-palatalized. Subapical retroflex non-sibilants also occur but tend to be palatal, as for sibilants.

Non-palatalized/Retroflex

1. Retroflex Stops, Nasals, and Laterals: Retroflex stops, nasals, and laterals – like [long t, right hook n, right hook l] occur in a number of languages across the world such as South Asian languages, i.e., Hindi, and various East Asian languages such as Vietnamese.
2. Uncommon Occurrence in European Languages: The sounds are fairly rare in European languages but occur, for example, in Swedish; they are then considered to be allophones of sequences such as /rn/ or /rt/.
3. Dentals vs Alveolars Stops/Nasals: Also, for some languages that distinguish "dental" vs. "alveolar" stops and nasals, they are actually articulated closer to prealveolar and postalveolar, respectively.
4. Rhotic Consonant as Retroflex Approximant: The normal rhotic consonant *r*-sound in American English is a retroflex approximant [inverted r right hook] – the equivalent in British English is an alveolar approximant [inverted r right stem].
5. Retroflex Rhotics and its Variants: Retroflex rhotics of various sorts, especially approximants and flaps, occur commonly in world's languages.
6. Retroflex Trills in Dravidian Languages: Some languages also have retroflex trills. Tamil and Malayalam have two trills, at least for many speakers, [r above dot] and [r above line], the latter of which is a retroflex.

7. Retroflex Trills in Toda Languages: Toda is particularly unusual in that it has six trills, including a palatalized/non-palatalized distinction and a three-way place distinction among dental, alveolar, and retroflex trills.

Palatalized

1. Distinction between Alveolopalatal and Palatoalveolar: Palatalized postalveolar non-sibilants are usually considered to be alveolopalatal. Some non-sibilant sounds in some languages are said to be palatoalveolar rather than alveolopalatal, but in practice, it is unclear if there is any consistent acoustic distinction between these two types of sounds.
2. Variations of Palatals and Palatalizations: In phonological descriptions, alveolopalatal postalveolar non-sibilants are not usually distinguished as such but are considered to be variants either palatal non-sibilants such as [c ,n (upside down y)], or palatalized alveolar non-sibilants such as [t^j n^j l^j].
3. Case of Nasal/Lateral Non-sibilants: Even the two types are not distinguished among nasals and laminals, as almost all languages have only one palatalized/palatal nasal or lateral in their phonemic inventories.
4. Palatal Lateral in Romance Languages: For example, the sound described as a "palatal lateral" in various Romance languages and often indicated as /upside down y/ is most often the alveolopalatal [(l above line)^j] – like in Catalan and Italian, and sometimes a palatalized alveolar [l^j], such as in some northern Brazilian Portuguese dialects.
5. IPA Symbols for Alveolopalatal Non-sibilants: The IPA does not have specific symbols for alveolopalatal non-sibilants, but they can be denoted using the advanced diacritic like <(c above +) (n left hook above +) (upside down y above +)>.
6. Sinologist Symbology for Non-sibilant Consonants: Sinologists often use special symbols for alveolopalatal non-sibilants, <t above curl n above curl l above curl>, created by analogy with curl marks used to mark alveolopalatal sibilants. However, the actual sounds indicated

using these symbols are often palatal and palatalized alveolar rather than alveolopalatal, like the variation for symbols like [n left hook upside down y].

7. Alveolopalatals in East Asian Languages: The decision to use special alveolopalatal symbols in Sinology is largely based on the distributional similarities between the sounds in question and the alveolopalatal sibilants, which are prominent in many East Asian languages.
8. Sounds in the Dental-to-Palatal Region: However, a few languages distinguish the alveolopalatal from other palatalized non-sibilants in the dental-to-palatal region.
9. Three Way Distinction in Irish: Many conservative dialects of Irish have a three-way distinction among palatalized nasals between dorsal palatal [n left hook], laminal alveolopalatal [(n above bar)^j], and apical palatalized alveolar [n^j].
10. Differences in Lower/Upper Articulators: That is typical with oppositions among similar sounds in a single language, the sounds being maximally different in that each one differs both in the point of contact on the tongue – dorsal vs. laminal vs. apical, and the roof of the mouth – palatal vs. palatoalveolar vs. alveolar from all others.
11. Two Way Distinctions in Non-sibilants: The other dialects have lost one of the two palatalized coronals but still have a two-way distinction. A similar distinction between palatal [,n] and alveolopalatal [(n above bar)^j] exists in some nonstandard forms of Malayalam.

Examples

1. Distinguishing Palatalized and Non-palatalized Postalveolars: Some languages distinguish palatalized, i.e., alveolopalatal, and non-palatalized, i.e., retroflex, postalveolar nasals and/or laterals.
2. Non-sibilant Variations in Australian Languages: Some Australian languages distinguish four coronal nasals and laterals: laminal dental [(n above dome) (l above dome)], apical alveolar [n l], laminal postalveolar – palatalized – [(n above bar)^j (l above bar)^j], and apical postalveolar – retroflex – [n right hook l right hook].

3. Variation in Standard/Dialectical Malayalam: The non-standard Malayalam dialects mentioned above have five acute – including four coronal – nasals: laminal dental [n above dome], apical alveolar [n], laminal postalveolar – palatalized – [(n above bar)^j], subapical palatal – retroflex [n right hook], and dorsal palatal – palatalized – [n left hook]; these are in addition to labial [m] and velar [n left hook]. Standard Malayalam lacks the laminal and palatalized postalveolar.
4. Nasals in Conservative Irish Dialects: The conservative Irish dialects mentioned above also have five acute nasals, again including four coronals; however, only four different primary articulations are involved, as a secondary velarized/palatalized distinction is at play.
5. Corresponding Active and Passive Articulators: The sounds in question are laminal dental velarized [(n above dome) super (v above degree)], apical alveolar velarized [n super (v above degree)], apical alveolar palatalized [n^j], laminal postalveolar – palatalized – [(n above bar)^j], and dorsal palatal [n left hook] – all in addition to labial velarized [m super (v above degree)], labial palatalized [m^j], and velar [n right left hook].
6. Coronals in other Irish Dialects: The above 8 sounds participate in 4 velarized/palatalized pairs: [m super (v above degree) m^j]; [(n above dome) super (v above degree) (n above bar)^j]; [n super (v above degree) n^j]; [n right left hook n left-left hook]. Other dialects have variously reduced the nasals to three or two.

Postalveolar Clicks

1. Two Types of Postalveolar Clicks: There are two types of postalveolar clicks that can occur, commonly described as "postalveolar" and "palatal", but they would perhaps be more accurately described as apical and laminal, respectively.
2. Apical Postalveolar Click:

IPA	Language	Orthography	IPA	Meaning

	Nama			hollow

3. Laminal Postalveolar Click:

IPA	Language	Orthography	IPA	Meaning
	!Kung			To imitate

References

- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Wikipedia (2021): Postalveolar Consonant

Velar Consonant

Overview

1. Articulation against the Soft Velum: Velars are consonants articulated with the back of the tongue – the dorsum – against the soft palate, the back part of the roof of the mouth – also known as the velum (Wikipedia (2021)).
2. Fronted and Retracted velar Assimilation: Since the velar region of the roof of the mouth is relatively extensive and the movements of the dorsum are not very precise, velars easily undergo assimilation, shifting their articulation back or to the front depending on the quality of the adjacent vowels. They often become automatically partly or completely *fronted*, that is partly or completely palatal before a following front vowel, and *retracted*, that is partly or completely uvular before back vowels.
3. Palatalized Velars called as Palatovelars: Palatalized velars – like English /k/ in *keen* or *cube* – are sometimes referred to as *palatovelars*.
4. Labialized Velars - Rounding of the Lips: Many languages also have labialized velars, such as [k^w], in which the articulation is accompanied by rounding of the lips.
5. Labial Velar Consonants - Lip/Velum Articulators: There are also labial-velar consonants, which are doubly articulated at the velum and at the lips, such as [kp hat].
6. Labialized Approximant Velar called Labiovelars: This distinction disappears with the approximant consonant [w] since labialization involves adding of a labial approximation articulation to a sound, and this ambiguous situation is often called *labiovelar*.
7. Absence of Trills/Taps/Flaps: A velar trill or tap is not possible according to the International Phonetic Association. In the velar position, the tongue has an extremely restricted ability to carry out the type of motion associated with trills or taps, and the body of the tongue has no freedom to move quickly enough to produce a velar trill or flap.

Examples

1. Velar Nasal: The velar consonants identified by the International Phonetic Alphabet:

IPA	Language	Orthography	IPA	Meaning
	English			ring

2. Voiceless Velar Plosive:

IPA	Language	Orthography	IPA	Meaning
	English			Skip

3. Voiced Velar Plosive:

IPA	Language	Orthography	IPA	Meaning
	English			get

4. Voiceless Velar Fricative:

IPA	Language	Orthography	IPA	Meaning
	German			abdomen

5. Voiced Velar Fricative:

IPA	Language	Orthography	IPA	Meaning

	Greek			Cat

6. Voiceless Labialized Velar Approximant: In dialects that distinguish between *which* and *witch*:

IPA	Language	Orthography	IPA	Meaning
	English			which

7. Voiced Velar Approximant: Intervocalic *g* in Spanish is often described instead as a very highly articulated voice velar fricative

IPA	Language	Orthography	IPA	Meaning
	Spanish			to pay

8. Voice Velar Lateral Approximant:

IPA	Language	Orthography	IPA	Meaning
	Wahgi			dizzy

9. Voice Labiovelar Approximant:

IPA	Language	Orthography	IPA	Meaning
	English			witch

10. Velar Ejective Stop:

IPA	Language	Orthography	IPA	Meaning

	Archi			Bottom

11. Voiced Velar Implosive:

IPA	Language	Orthography	IPA	Meaning
	Sindhi			Heavy

12. Back-released Velar Click:

IPA	Language
	Paralinguistic

Lack of Velars

1. Frequent Occurrence of the Velar [k]: The velar consonant [k] is the most common consonant in human languages (Maddieson and Disner (1984)). The only languages recorded to lack velars – and any dorsal consonants at all – may be Xavante, Tahitian, and – phonologically but not phonetically – several Skou languages, Wutung, a dialect of Vanimo, and Bobe. In Piraha, men may lack the only velar consonant.
2. Languages that lack Simple Velars: Other languages lack simple velars. An areal feature of the indigenous languages of the Americas of the coastal regions of the Pacific Northwest is that historical *k was palatalized. When such sounds remained stops, they were transcribed <k^y> in the Americanist phonetic notation, presumably corresponding to the IPA <c>, but in others, such as the Saanich dialect of coastal Salish, Salish-Spokane-Kalispel, and Chemakum, *k went further and affricated to [t integral]. Likewise, historical *k' has become [t integral '] and historical *x has become [integral]; there was no *g or *n,.

3. [k] in Northwest Caucasus Languages: In the Northwest Caucasus languages, the historical *[k] has become palatalized, becoming /k^j/ in Ubykh, and /t integral/ in most Circassian varieties. In both regions, the languages retain a labialized velar series – [k^w], [k'w], [xw], [w] in the Pacific Northwest – as well as uvular consonants (Chirikba (1996)).
4. Distinction between Pre-Velar and Post-Velar: In the languages of those families that retain the plain velars, both plain and labialized velars are *pre-velar*, perhaps to make them more distinct from the uvulars, which may be *post-velar*.
5. Palatalization of the Pre-velar Consonants: Pre-velar consonants are susceptible to palatalization. A similar system, contrasting *k^w with *k^j and leaving *k marginal at best, is reconstructed for Proto-Indo-European.
6. Velars apart from [k]/[g]: Apart from the voiced stop [g], no other velar consonant is particularly common, even the [w] and [n,] that occur in English.
7. Frequency of the Velar [g]: Of course, there can be no phoneme [g] in a language that lacks vocal stops, like Mandarin Chinese – what is written g in pinyin is /k/, though that sound does have an allophone [g] in atonic syllables – but it is sporadically missing elsewhere. Of the languages surveyed in the *World Atlas of Language Structures*, about 105 of languages that have /p b t d k/ are missing [g].
8. [k] and [g] in Piraha: Piraha has both a [k] and a [g] phonetically. However, [k] does not behave as other consonants, and the argument has been made that it is phonemically /hi/, leaving Piraha with only /g/ as an underlying velar consonant.
9. Velars in the Hawaiian Languages: Hawaiian does not distinguish [k] from [t]; <k> tends towards [k] at the beginning of the utterances, [t] before [i], and is a variable elsewhere, especially in the dialects of Ni'ihau and Kaua'i. Since Hawaiian has no [n,], and <w> varies between [w] and [v], it is clearly not meaningful to say that Hawaiian has phonemic velar consonants.
10. Velars in the Khoisan Languages: Several Khoisan languages have limited numbers or distributions of pulmonic velar consonants. Their click consonants are articulated in the uvular or possibly the velar region, but that occlusion is part of the airstream mechanism rather than the place of articulation of the consonant. Khoekhoe, for example, does not allow velars in medial or final positions, but in Jul'hoan velars are rare even in the initial position.

Velodorsal Consonants

1. Normal Velar Consonants are *Dorso-velar*: The dorsum/body of the tongue rises to contact the velum/soft palate of the roof of the mouth.
2. Velodorsal Stops in Disordered Stops: In disordered speech, there are also *velo-dorsal* stops, with the opposite articulation: the velum lowers to contact the tongue, which remains static.
3. Velodorsal Transcription in Extended IPA: In the extensions to the IPA for disordered speech, these are transcribed by reversing the IPA letters for a velar consonant, e.g., < > <laterally inverted k> for a voiceless Velodorsal stop – the old letter for a back-released velar click, turned-k < upside down k>, was used from 2008 to 2015 - < > <laterally inverted g> for voiced, and < > <laterally inverted ,n> for nasal.

References

- Chirikba, V. A. (1996): *Common West Caucasian: The Reconstruction of its Phonological System and Parts of its Lexicon and Morphology* **CNWS Publishers** Leiden, Netherlands
- Maddieson, I., and S. F. Disner (1984): *Patterns of Sounds* **Cambridge University** Cambridge, UK
- Wikipedia (2021): Velar Consonant

Uvular Consonant

Overview

1. Place of Articulation for Uvular: *Uvulars* are consonants articulated at the back of the tongue against or near the uvula, that is, further back in the mouth than the velar consonants (Wikipedia (2021)).
2. Manner of Articulation for Uvulars: Uvulars may be stops fricatives, nasals, trills or approximants, through the IPA does not provide a separate symbol for approximant, and the symbol for voiced fricative is used instead.
3. Occurrence of Uvular Affricate Variants: Uvular affricates can certainly be made but are rare: they occur in some Southern High-German dialects, as well as in a few African and Native American languages. Ejective uvular affricates occur as realizations of uvular stops in Lillooet and Kazakh, or as allophonic realizations of the ejective uvular fricative in Georgian.
4. Influence of ATR/Neighboring Vowels: Uvular consonants are typically incompatible with advanced tongue Root (Vaux (1999)), and they often cause retraction of neighboring vowels.

Uvular Consonants in IPA

1. Voiced Uvular Nasal:

IPA	Language	IPA	Meaning
	Japanese		Japan

2. Voiceless Uvular Plosive:

IPA	Language	IPA	Meaning
	Arabic		A story

3. Voiced Uvular Plosive:

IPA	Language	IPA	Meaning
	Inuktitut		Because I return

4. Voiceless Uvular Fricative:

IPA	Language	IPA	Meaning
	Peninsular Spanish		Skinny

5. Voiced Uvular Fricative:

IPA	Language	IPA	Meaning
	French		To stay

6. Voiced Uvular Trill:

IPA	Language	IPA	Meaning
	French – 20th Century Paris Accent		Paris

7. Voiceless Uvular Trill:

IPA	Language
	Bainounk Gubeeher

8. Uvular Ejective Stop:

IPA	Language	IPA	Meaning
	Quechua		Tomato sauce

9. Uvular Ejective Affricate:

IPA	Language
	Wintu

10. Uvular Ejective Fricative:

IPA	Language	IPA	Meaning
	Tlingit		‘fire’

11. Voiced Uvular Implosive:

IPA	Language	IPA	Meaning
	Mam		Fire

12. Voiceless Uvular Implosive:

IPA	Language	IPA	Meaning
	Q’anjob’al		‘Q’anjob’al language’

13. Voiced Uvular Flap:

IPA	Language	IPA	Meaning
	Hiw		‘hibiscus’

14. Voiced Uvular Approximant:

IPA	Language	IPA	Meaning
	Danish		red

15. Voiced Uvular Lateral Approximant:

IPA	Language	IPA	Meaning
	English (some American speakers)		‘wool’

Descriptions in Different Languages

1. In English/Australian/Pacific Languages: English has no uvular consonants – at least in most major dialects – and they are unknown in the indigenous languages of Australia and the Pacific, though uvular consonants separate from the velar consonants are believed to have existed in the Proto-Oceanic language and are attested in the modern Formosan languages of Taiwan.
2. African and Middle-Eastern Languages: Uvular consonants are, however, found in many African and Middle-eastern languages, most notably Arabic, and in Native American languages.

3. Caucasus and NW North America: In parts of the Caucasus mountains and northwestern North America, nearly ever language has uvular stops and fricatives.
4. In Northwestern European languages: Two uvular R phonemes are found in various languages in north-western Europe including French, some Occitan dialects, a majority of German dialects, some Dutch dialects, and Danish.
5. Uvular Stop Transcription and Pronunciation: The voiceless uvular stop is transcribed as [q] in both the IPA and SAMPA. It is pronounced somewhat like the voiceless velar stop [k], but with the middle of the tongue further back on the velum, against or near the uvula.
6. Translation of Arabic to English: The most familiar use will doubtless be in the transliteration of Arabic place names such as *Qatar* and *Iraq* into English, though, since English lacks this sound, this is generally pronounced as [k], the sound that it most similar to what occurs in English.
7. Occurrence of the Uvular Ejective: [q’], the uvular ejective, is found in Ubykh, Tlingit, Cusco Quechua, and some others. In Georgian, the occurrence of this phoneme is debatable, since the general realization of the letter “Ყ” is /χ'/. This is due to /q^h/ merging with /χ/ and therefore /q’/ being influenced by this merger and becoming /χ'/.
8. Occurrence of the Voiced Uvular Stop: [G], the voiced equivalent of [q], is much rarer. It is like the voiced velar stop [g], but articulated in the same uvular position as [q].
9. Voiced Uvular in Persian/NE Caucasus: Few languages use this sound, but it is found in Persian and in several Northeast Caucasus languages, notably Tabasaran. It may also occur as an allophone of another consonant – in Kazakh, voiced uvular stop is an allophone of the voiced uvular fricative after the velar nasal.
10. Occurrence of Voiceless Uvular Fricative: The voiceless uvular fricative [χ] is similar to the voiceless velar fricative [x], except that it occurs near the uvula. It is found in Georgian, and in place of [x] in some dialects of German, Spanish, and Arabic, as well as in some dialects of Dutch and in standard Afrikaans.
11. Occurrence of the Uvular Flap: Uvular flaps have been reported for Kube – in Trans new-Guinea – and in the variety of Khmer spoken in Battambang.
12. Enqi Dialect of Bai Language: The Enqi dialect of the Bai language has an unusually complete series of the uvular consonants consisting of the stops /q/, /q^h/, and /G/, the fricatives /χ/ and /upside down R/, and the nasal /N/. All of these contrast with a

corresponding velar consonant of the same manner of articulation (Feng (2006)). The existence of uvular nasal is especially unusual, even more so than the existence of the voiced stop.

13. Uvulars in Ubykh and Tlingit: The extinct Ubykh language of Turkey has 20 uvular consonants. The Tlingit language of the Alaskan Panhandle has 10, all of which are voiceless obstruents.
14. Uvulars in Tlingit:

Tenuis Stop		Tree Spine
Aspirated Stop		Basket
Ejective Stop		Screech owl
Labialized Tenuis Stop		Octopus
Labialized Aspirated Stop		People, tribe
Labialized Ejective Stop		Cooking pot
Voiceless Fricative		Fingernail
Ejective Fricative		Freshwater Sockeye Salmon
Labialized Voiceless Fricative		Canvas, denim
Labialized Ejective Fricative		Down (feathers)

Phonological Representation

1. Uvular Representation in Featural Phonology: In featural phonology, uvular consonants are most often considered to contrast with velar consonants in terms of being [-high] and [+back]. Prototypical uvulars also appear to be [-ATR] (Vaux (1999)).

2. Contrasting Palatalized Velars and Palatalized Uvulars: Two variants can be established. Since palatalized consonants are [-back], the appearance of palatalized uvulars in a few languages such as Ubykh is difficult to account for. According to Vaux (1999), they possibly hold the features [+high], [-back], [-ATR], the last being te distinguishing feature from a palatalized velar consonant.

Uvular Rhotics

1. Uvular Trill in European Dialects: The uvular trill [R] is used in certain dialects – especially those associated European capitals – of French, German, Dutch, Portuguese, Danish, Swedish, and Norwegian, as well as sometimes in Modern Hebrew, for the rhotic phoneme. In many of these it has a uvular fricative – either voiced [upside down R] or voiceless [χ] – as an allophone when it follows one of the voiceless stops /p/, /t/, or /k/ at the end of a word, as in the French example $maître$ [$m\varepsilon t\chi$], or even a uvular approximant.
2. Reduction to a Single Contact: As with most other trills, uvular trills are often reduced to a single contact, especially between vowels.
3. Trill Articulation without Tongue Retraction: Unlike other uvular consonants, the uvular trill is articulated without a retraction of the tongue, and therefore doesn't lower neighboring high vowels the way uvular stops commonly do.
4. Uvular Fricatives as Rhotic Consonants: Several other languages, including Inuktitut, Abkhaz, Uyghur, and some varieties of Arabic, have a voiced fricative but do not treat it as a rhotic consonant. However, Modern Hebrew and some modern varieties of Arabic both have at least one uvular fricative that is considered non-rhotic, and one that is considered rhotic.
5. Adaptation in the Lakhota Language: In Lakhota the uvular trill is an allophone of the voiced uvular fricative before /i/.

References

- Feng, W. (2006): Comparison of Languages in Contact: The Distillation Method and the Case of Bai, in: *Language and Linguistics Monograph Series B – Frontiers in Linguistics, Editor: Wang, W. S. Y.* **Academia Sinica** Taipei, Taiwan
- Vaux, B. (1999): *A Note on Pharyngeal Features* **Harvard Working Papers on Linguistics** Cambridge, MA
- Wikipedia (2021): Uvular Consonant

Guttural

Overview

1. <u>Articulated at Posterior Oral Cavity</u>: *Guttural* speech sounds are those with a primary place of articulation near the back of the oral cavity (Wikipedia (2021)).
2. <u>Includes Pharyngeal, Velar, and Uvular Consonants</u>: In some definitions, this is restricted to pharyngeal consonants, but in others includes some velar and uvular consonants.
3. <u>Mostly Consonants with some Vowels</u>: Guttural sounds are typically consonants, but some vowels' articulations may also be considered guttural in nature.
4. <u>Imprecise Nature of the Term</u>: Although the term has been historically used by phoneticians, and is occasionally used by phonologists today, its technical use is now limited, and is more common in popular use as an imprecise term for sounds produced relatively far back in the vocal tract.
5. <u>Murmured, Pharyngealized, Glottalized, Strident Vowels</u>: The term does, however, continue to be used by some phonologists to denote laryngeal consonants – including uvulars, as well as murmured, pharyngealized, glottalized, and strident vowels (Pullum and Ladusaw (1996), Miller (2007)). Some phonologists argue that all post-velar sounds constitute a natural class (Moisik, Czaykowska-Higgins, and Esling (2021)).

Meaning and Etymology

1. <u>Meaning of *Guttural* and Early Usage</u>: The word *guttural* literally means 'of the throat' – from Latin *guttur* meaning throat – and was first used by phoneticians to describe the Hebrew glottal [?] - א - and [h] – cracked pi, uvular [] – cracked pi, and pharyngeal [mirror image χ] – cracked v.
2. <u>Extension to include Velar Consonants</u>: The term is now commonly extended to include velar consonants, which deviates from strict etymology. As used in linguistics, such definition includes all velar consonants, regardless of the manner of articulation.
3. <u>Colloquial Use to indicate *Grating*</u>: The term is also commonly used non-technically by English speakers to refer to sounds that subjectively appear harsh or grating.
4. <u>Epiglottal, Uvular, and Velar Fricatives</u>: This definition usually includes a number of consonants that are not used in English, such as the epiglottal [h] and [crossed question], uvular [χ], [upside down R], and [q], and velar fricatives [x] and [v over degree].
5. <u>Sounds Excluded from the Term</u>: However, it usually excludes sounds used in English, such as the velar stops [k] and [g], the velar nasal [n,], and the glottal consonants [h] and [?] (McCarthy (1989)).

Guttural Languages

In popular consciousness, languages that make use of guttural consonants are often considered to be *guttural languages*. English speakers find such languages strange and even hard on the ear (Hayward and Hayward (1989)).

Examples of Significant Usage

1. Languages using [x], [χ], [upside down R], [v over degree], [q]: The following are some of the languages that extensively use [x], [χ], [upside down R], [v over degree], and/or [q].
    a. Afrikaans => Wells (2011)
    b. Arabic
    c. Armenian
    d. Assamese
    e. Assyrian Neo-Aramaic => Beyer (1986), Brock (2006)
    f. Azerbaijan => Shiraliyev (1957)
    g. Crimean Tartar
    h. Dutch => Maurer (1942) uses the term *Istvaeonic* instead of Franconian
    i. French
    j. German => Cercignani (1979)
    k. Irish
    l. Manx
    m. Hindustani => Hindi, Urdu
    n. Hebrew
    o. Mongolian Language
    p. Kartvelian Languages => Georgian, Mingrelian, Laz, Svan
    q. Kurdish
    r. Pashto => Habib (1967)
    s. Persian => Lazard (1971)
    t. Scottish Gaelic => Bauer (2011)
    u. Spanish
    v. Tajik Persian => Baizoyev and Hayward (2003)
    w. Tswana
    x. Welsh => Wells (1982)
2. Languages using [mirror image ?] and [h cross]: In addition to their usage of [x], [χ], [upside down R], [v over degree], and/or [q], the following languages also have the pharyngeals consonants [mirror image ?] and [h cross].
3. Berber Languages: i.e., Kabyleh, Tamasheq

4. Cushitic Languages: i.e., Somali, Amharic, Tigrinya, Oromo, Ge'ez (Sava and Tosco (2003), Sands (2009)).
5. Indo-Aryan Languages: Hindustani
6. Some Kurdish Dialects: As a result of borrowings from Arabic (Haig and Matras (2002))
7. Northeast Caucasus Languages: i.e., Chechen, Lezgian, and Avar (Hewitt (2004), Plaster, Polinsky, and Harizanov (2012)).
8. Northwest Caucasus: i.e., Abkhaz, Adyghe, Kabardian (Nichols (1997)).
9. Salishan and Wakashan Language Families in British Columbia: Jorgensen (1969).
10. Semitic Languages: i.e., Arabic, Chaldean, Neo-Aramaic, Turoyo, Hebrew (Kaufman (1997), Garnier and Jacques (2012)).

Examples of Partial Usage

1. French: In French, the only truly guttural sound is usually a uvular fricative – or the guttural sound R.
2. Portuguese: In Portuguese, the [upside down R] is becoming dominant in urban areas. There is also a realization as a [χ], and the original pronunciation as an [r] also remains very common in various dialects.
3. Russian: In Russian, /x/ is assimilated to the palatalization of consonants before /i/ as /x^h/. It also has a voiced allophone [v over degree], which occurs before voiced obstruents.
4. Romanian: In Romanian, /h/ becomes the velar [x] in word-final position – *duh* 'spirit' – and before consonants – *hrean* 'horseradish'.
5. Czech: In Czech, the phoneme /x/ followed by a voiced obstruent can e realized as either [h with hook above] or [v over degree] (Kucera (1961)).
6. Kyrghyz: In Kyrghyz, the consonant phoneme /k/ has a uvular realization [q] in back vowel contexts. In front-vowel environments, /g/ is fricativized between continuants to [v over degree], and in back vowel environments bot /k/ and /g/ fricativize to [χ] and [upside down R] respectively.

7. <u>Uyghur</u>: In Uyghur, the phoneme /upside down R/ occurs with a back vowel.
8. <u>Mongolian</u>: In the Mongolian language, /x/ is usually followed by /n,/.
9. <u>Khoisan Languages</u>: The Tuu and the Juu – Khoisan languages of southern Africa – have large numbers of guttural vowels. These sounds share certain phonological behaviors that warrant the use of the term specifically for them. There are scattered reports of pharyngeals elsewhere, such as in the Nilo-Saharan, Tama language.
10. <u>Swabian German</u>: In Swabian German, a pharyngeal approximant [mirror image question mark] is an allophone of /upside down R/ in nucleus and code positions. In onsets, it is pronounced as a uvular approximant.
11. <u>Danish</u>: In Danish, / upside down R/ may have a slight frication, and, according to Ladefoged and Maddieson (1996), it may be a pharyngeal approximant [mirror image question mark].
12. <u>Finnish</u>: In Finnish, a weak pharyngeal fricative is the realization of /h/ after the vowels /a/ or /a e overlap/ in syllable code position.

References

- Baizoyev, A. and J. Hayward (2003): *A Beginner's Guide to Tajiki* **Routledge** New York, NY
- Bauer, M. (2011): *Blas na Gaidhlig – The Practical Guide to Gaelic Pronunciation* **Akerbeltz** Glasgow, UK
- Beyer, K. (1986): *The Aramaic Language: Its Distribution and Sub-divisions* **van den Hoeck und Ruprecht** Gottingen, Germany
- Brock, S. (2006): *An Introduction to Syriac Studies* **Gorgias Press** Piscataway, NJ
- Cercignani, F. (1979): *The Consonants of German: Synchrony and Diachrony* **Cisalpino** Milan, Italy
- Garnier, R., and G. Jacques (2012): A Neglected Phonetic Law: The Assimilation of Pretonic Yod to a Following Coronal in North-west Semitic *Bulleting of the School of Oriental and African Studies* **75 (1)** 135-145

- Habib, A. (1967): The Two Thousand Years Old Language of Afghanistan or The Mother of Dari Language (An Analysis of the Baghlan Inscription)
- Haig. G., and Y. Matras (2002): Kurdish Linguistics: A Brief Overview *Sprachtypologie und Universalienforschung* **55 (1)** 3-14
- Hayward, K. M., and R. J. Hayward (1989): "Gutturals" – Arguments for a New Distinctive Feature *Transactions of the Philological Society* **87** 179-193
- Hewitt, G. (2004): *Introduction to the Study of the Languages of the Caucasus* **LINCOM Europa** Munich, Germany
- Jorgensen, J. G. (1969): *Salishan Language and Culture* **Indiana University Press** Bloomington, IN
- Kaufman, S. (1997): Aramaic, in: *The Semitic Languages, Editor: Hetzron. R.* **Routledge** New York, NY
- Kucera, H. (1961): *The Phonology of Czech* **Mouton and Co.** Gravenhage, Netherlands
- Kyzlasov, I. L. (1994): *Runic Scripts of Eurasian Steppes* **Eastern Literature** Moscow, Russia
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of the World's Languages* **Blackwell** Oxford, UK
- Lazard, G. (1971): Pahlavi, Parsi, Dari: Les Langues d'Iran d'apes Ibn al-Muqaffa, in: *Iran and Islam: In Memory of the Late Vladimir Minorsky, Editor: Frye, R. N.* **Edinburgh University Press** Edinburgh, UK
- Maurer, F. (1942): *Nordgermanen und Alemannen: Studien zur Germanischen und Fruhdeutschen Sprachgeschichte, Stammes- und Volkskunde* **Verlag Francke** Bern, Switzerland
- McCarthy, J. J. (1989): The Phonetics and Phonology of Semitic Pharyngeals
- Miller, A. (2007): Guttural Vowels and Guttural Co-articulation in Jul'hoansi *Journal of Phonetics* **35 (1)** 56-84
- Moisik, S., E. Czaykowska-Higgins, and J. Esling (2021): Phonological Potentials and the Lower Vocal Tract **51 (1)** 1-35
- Nichols, J. (1997): Nikolaev and Starostin's North Caucasian Etymological Dictionary and the Methodology of Long-Range Comparison: An Assessment *10th Biennial Non-Slavic Languages (NSL) Conference* Chicago, IL

- Plaster, K., M. Polinsky, and B. Harizanov (2012): Noun Classes Grow on Trees
- Pullum, G. K., and W. Ladusaw (1996): *Phonetic Symbol Guide 2nd Edition* **University of Chicago Press** Chicago, IL
- Sands, B. (2009): Africa's Linguistic Diversity *Language and Linguistics Compass* **3 (2)** 559-580
- Sava, G., and M. Tosco (2003): The Classification of Ongota, in: *Selective/Comparative Historical Papers in Memory of Igor M. Diakonoff, Editors: Bender, L. M., D. Appleyard, and G. Takacs* **LINCOM Europa** Munich, Germany
- Shiraliyev, M. (1957): *The Baku Dialect* **Azerbaijan SSR Academy of Sciences Publishers** Baku, Azerbaijan
- Wells, J. (1982): *Accents of English* **Cambridge University Press** Cambridge, UK
- Wells, J. (2011): Velar or Uvular?
- Wikipedia (2021): Guttural

Laryngeal Consonant

Overview

1. Consonants with Articulation near the Laryngeal Area: *Laryngeal consonants*, a term used often interchangeably with guttural consonants, are consonants with their primary articulation in the larynx (Wikipedia (2021)). The laryngeal consonants comprise the pharyngeal consonant including the epiglottals, the glottal consonant (Esling (2010) – who has abandoned epiglotto-pharyngeal as a distinct articulation), and for some languages uvular consonants (Moisik, Czaykowska-Higgins, and Esling (2012)).
2. Broader Use of the Term: The term *laryngeal* is often taken to be synonymous with *glottal*, but the larynx consists of more than just the glottis, i.e., the vocal folds: it includes the epiglottis and the aryepiglottic folds. In a broad sense, therefore, laryngeal articulations include the radical consonants, which involve the root of the tongue. The diversity of the sounds produced in the larynx is the subject of ongoing research, and the terminology is evolving.
3. Usage to include Laryngealized Consonants: The term *laryngeal consonant* is also used for the laryngealized consonants articulated in the upper vocal tract, such as Arabic ‘emphatics’ and Korean ‘tense’.

References

- Esling. J. (2010): Phonetic Notation, in: *The Handbook of Phonetic Sciences 2nd Edition Editors: Hardcastle, W. J., J. Laver, and F. E. Gibbon* **Wiley-Blackwell** Hoboken, NJ
- Moisik, S., E. Czaykowska-Higgins, and J. Esling (2012): The Epilaryngeal Articulator: A New Conceptual Tool for Understanding Lingual-Laryngeal Contrasts
- Wikipedia (2021): Laryngeal Consonant

Retroflex Consonants

Overview

1. Definition of a Retroflex Consonant: A *retroflex*, *apico-domal*, or *cacuminal consonant* is a coronal consonant where the tongue has a flat, concave, or even curled shape, and is articulated between the alveolar ridge and the hard palate. They are sometimes referred to as *cerebral consonants* – especially in Indology (Wikipedia (2021)).
2. Subapical, or True, Retroflex Consonants: The Latin-derived word *retroflex* means "bent back"; some retroflex consonants are pronounced with the tongue fully curled back so that articulation involves the underside of the tongue tip, i.e., subapical. These sounds are sometimes described as "true" retroflex consonants.
3. Apical and Laminal Retroflex Consonants: However, retroflexes are commonly taken to include other consonants having a similar place of articulation without such extreme curling of the tongue; these may be articulated with the tongue tip, i.e., apical, or the tongue blade, i.e., laminal.

Types

1. Varieties among Retroflex Consonant Families: Retroflex consonants, like other coronal consonants, come in several varieties, depending on the shape of the tongue. The tongue may be either flat or concave, or even with the tip curled back.

2. Tongue Contact - Apical, Laminal, Subapical: The point of contact with the tongue may be with the tip, i.e., apical, with the blade, i.e., laminal, or the underside of the tongue, i.e., subapical.
3. Roof Contact - Alveolar, Postalveolar, Palatal: The point of contact on the roof of the mouth may be with the alveolar ridge – alveolar, the area behind the alveolar ridge – postalveolar, or the hard palate – palatal.
4. Sibilant and Non-sibilant Retroflex Consonants: Finally, both sibilant – fricatives or affricate, and non-sibilant – stop, nasal, lateral, rhotic – consonants can have a retroflex articulation.
5. Sibilants Account for the Greatest Variety: The greatest variety of combinations occurs with the sibilants, because for them, small changes in the tongue shape and position cause significant changes in the resulting sound.
6. Lower-pitched than Alveolar Consonants: Retroflex sounds generally have a duller, lower-pitched sound than other alveolar or postalveolar consonants, especially the grooved alveolar sibilants.
7. Point of Tongue Contact Determining the Pitch: The farther back the point of contact with the roof of the mouth, the more concave is the shape of the tongue, and the duller/lower pitched is the sound, with subapical consonants being the most extreme.
8. Laminal Postalveolar with Flat Tongue: The first of these main combinations observed is laminal postalveolar, with a flat tongue. These occur, for example, in Polish *cz*, *sz*, [z hat]/*rz*, *d z hat*, and Mandarin *zh*, *ch*, *sh*, and *r*.
9. Apical Postalveolar with Concave Tongue: The next combination is apical postalveolar, with a somewhat concave tongue. These occur, for example, in Hindi and other Indo-Aryan languages. Hindi has no retroflex sibilants, unlike some of the other Indo-Aryan languages.
10. Subapical Palatal with Concave Tongue: Subapical palatal, with a highly concave tongue, occur particularly in the Dravidian languages and some Indo-Aryan languages.
11. Pitch of Subapical Palatal Retroflex: They are the dullest and the lowest-pitched type and, after a vowel, of add a strong *r*-coloring to the vowel and sound as if an American English *r* occurred between the vowel and the consonant.
12. Tongue Shape - Not an Articulator: They are not a place of articulation, as the IPA chart implies, but a shape of the tongue analogous to laminal and apical (Esling (2010)).

13. Alternate Names for Subapical Reflex: Subapical sounds are sometimes called "true retroflex" because of the curled back shape of the tongue, and the other sounds sometimes go by other names. For example, Ladefoged and Maddieson (1996) prefer to call laminal postalveolar sounds "flat postalveolar".

Other Sounds

1. Co-locationally Articulated Non-retroflex Consonants: Retroflex sounds must be distinguished from other consonants made in the same parts of the mouth.
2. Palatoalveolar Consonants with some Examples: The palatoalveolar consonants, e.g., [integral weird z], such as *sh*, *ch*, and *zh* occurring in English words like *ship*, *ship*, and *vision*.
3. Alveolopalatal Consonants and their Examples: E.g., [c curled down z curled down], such as the *j*, *q*, and *x* occurring in Mandarin Chinese.
4. Dorsal Palatal Consonants with Examples: E.g., [c right left hook, j left hook, n left at left hook], such as the *ch* [c right left hook] in German *ich* or the n~ [n left at left hook] in Spanish *ano*.
5. Grooved Alveolar Consonants with Examples: E.g., [s z], such as the [s above bar] and the [z above bar] occurring in English words like *sip* and *zip*.
6. Consonants with Secondary Place of Articulation: The first three types of sounds above have a convex tongue shape, which gives them an additional secondary articulation of palatalization.
7. Hissing in Grooved Alveolar Consonants: The last has a groove running down the center line of the tongue, which gives it a strong hissing quality.
8. No Palatalization/Grooving in Retroflex: The retroflex sounds, however, have a flat or concave shape, with no associated palatalization, and no groove running down the tongue.

9. <u>Common Misnomer – Non-concave Retroflex Consonants</u>: The term "retroflex", in fact, literally means "bent back"/concave, although consonants with a flat tongue shape are commonly considered retroflex as well.

IPA Transcription

1. <u>Right-facing Hook at Bottom</u>: In the International Phonetic Alphabet, the symbols for the retroflex consonants are the same as that for the alveolar consonants, but with an addition of a right-facing hook to the bottom of the symbol.
2. <u>Voiced Retroflex Nasal</u>:

IPA	Language	IPA	Meaning
	Punjabi		Song

3. <u>Voiceless Retroflex Plosive</u>:

IPA	Language	IPA	Meaning
	Swedish		Party
	Hindi/Urdu		Island

4. <u>Voiced Retroflex Plosive</u>:

IPA	Language	IPA	Meaning
	Swedish		North
	Hindi/Urdu		Box

5. Voiceless Retroflex Fricative:

IPA	**Language**	**IPA**	**Meaning**
	Mandarin		Shanghai
	Hindi		Language

6. Voiced Retroflex Fricative:

IPA	**Language**	**IPA**	**Meaning**
	Russian		Toad
	Polish		Frog

7. Voiced Retroflex Approximant:

IPA	**Language**	**IPA**	**Meaning**
	Tamil		Tamil

8. Voiced Retroflex Lateral Approximant:

IPA	**Language**	**IPA**	**Meaning**
	Marathi		Baby
	Swedish		Karlstad

9. Voiced Retroflex Flap:

IPA	**Language**	**IPA**	**Meaning**
	Hausa		Sweeping

	Hindi/Urdu		Mud

10. <u>Voiced Retroflex Lateral Flap</u>:

IPA	Language	IPA	Meaning
	Pashto		Blind
	Marathi		Baby

11. <u>Voiceless Retroflex Lateral Fricative</u>:

IPA	Language	IPA	Meaning
	Toda		Summer

12. <u>Voiced Retroflex Lateral Fricative</u>: See Gowda (1972)

IPA	Language
	Ao

13. <u>Retroflex Ejective</u>:

IPA	Language	IPA	Meaning
	Gwich'in		Arctic Term

14. <u>Voiced Retroflex Implosive</u>:

IPA	Language	IPA	Meaning
	Ngadha		Good

15. Retroflex Click Release - Many Distinct Consonants:

IPA	Language	IPA	Meaning
	Central !Kung		Water

Other Conventions

1. Subapical Palatal vs. Apical/Laminal: Some linguists restrict these symbols for consonants with subapical palatal articulation, in which the tongue curls back and contacts the hard palate, and use the alveolar symbols with the obsolete IPA underdot symbol for an apical postalveolar articulation: <t underdot, d underdot, n underdot, s underdot, z underdot, l underdot, r underdot, upside down r underdot>, and use <integral right hook, weird z right hook> for laminal retroflex, as in Polish and Russian (Laver (1994)).
2. Transcription of Laminal Retroflex Consonants: The latter are also often transcribed with a retraction diacritic, as <s over bar>. Otherwise, they are typically, but inaccurately, transcribed as if they were postalveolar, as <integral>.
3. Transcribing Alveolar/Postalveolar/Alveolopalatal Articulations: Consonants with more forward articulations, in which the tongue touches the alveolar or postalveolar regions rather than the hard palate, can be indicated with the retracted diacritic, i.e., the underbar sign. This occurs especially for [s over bar z over bar]; other sounds indicated this way, such as <n over bar l over bar d over bar>, tend to refer to alveolopalatal rather than retroflex consonants.

Occurrence

1. <u>Frequency of Occurrence in World's Languages</u>: Although data are not precise, about 20 percent of the world's languages contain retroflex consonants of one sort or another (Maddieson and Disner (1984)). About half of these possess only retroflex continuants, with most of the rest having both stops and continuants.
2. <u>Concentration in Indian Subcontinent</u>: Retroflex consonants are concentrated in the Indian subcontinent, particularly in the Indo-Aryan and the Dravidian languages, but are found in other languages of the region as well, such as the Munda languages and Burushaski.
3. <u>In Afghanistan/Iran/Asian Languages</u>: The Nuristani languages of Eastern Afghanistan also have retroflex consonants. Among Eastern Iranian languages, they are common in Pashto, Wakhi, Sanglechi-Ishkashimi, and Munji-Yidgha. They also occur in other Asian languages such as Mandarin Chinese, Javanese, and Vietnamese.
4. <u>In Indigenous Australian/Pacific Languages</u>: The other major concentration is in the indigenous languages of Australia and the Western Pacific – notably New Caledonia. Here, most languages have retroflex nasals, plosives, and approximants.
5. <u>In Northern/Southern European Languages</u>: Retroflex consonants are relatively rare in the European languages, but occur in such languages as Swedish and Norwegian in Northern Europe, some Romance languages of Southern Europe – Sardinian, Sicilian, including Calabrian and Salentino, some Italian dialects such as Lunigianese in Italy, and some Asturian dialects in Spain – and, sibilants, only, Faroese and several Slavic languages, i.e., Polish, Russian, Serbo-Croatian, Slovak, and Sorbian.
6. <u>Retroflex Realizations in Swedish/Norwegian</u>: In Swedish and Norwegian, a sequence of *r* and a coronal consonant may be replaced by the coronal's retroflex equivalent. This is sometimes done for several consonants in a row after *r*.
7. <u>Retroflex Approximant and Sibilant Realization</u>: The retroflex approximant /upside down r right hook/ is an allophone of the alveolar approximant /upside down r/ in many dialects of American English, particularly in the Midwestern United States. Polish and Russian possess retroflex sibilants, but no stops or liquids at this place of articulation.
8. <u>In Indigenous Languages of Americas</u>: Retroflex consonants are largely absent from indigenous languages of Americas with the extreme south of South America, an area in the Southwestern United States as in Hopi and O'odham, and in Alaska and the Yukon territory as in the Athabaskan languages Gwich'in and Han.

9. In Nilo-Saharan and Bantu Languages: In African languages retroflex consonants are also rare but occur reportedly in a few Nilo-Saharan languages, as well as in the Bantu language Makhuwa and some other varieties.
10. In Southwest Ethiopian Omotic Languages: In southwest Ethiopia, phonemically distinctive retroflex consonants are found in Bench and Sheko, two contiguous, but not closely related, Omotic languages (Breeze (1988)).
11. Instances with No IPA Symbols: There are several retroflex consonants that are not yet recognized by the IPA. For example, the Iwaidja language of Northern Australia has a retroflex lateral flap [long stem upside down r right hook] as well as a retroflex tap [r right hook] and retroflex lateral approximant [l right hook]; and the Dravidian language Toda has a subapical retroflex fricative [degree above l right hook small upside-down capital t] and a retroflexed trill [r right hook r].
12. Similarities between Retroflex and Alveolar: Because of the regularity of deriving retroflex symbols from their alveolar counterparts, people occasionally use a font editor to create the appropriate symbols for their sounds. In this chapter they were written with diacritics.
13. In Ngad'a, Juu Central, Damin: The Ngad'a language of Flores has been reported to have a retroflex implosive [d up and down right hook], but in this case the expected symbol is coincidentally supported by Unicode. Subapical retroflex clicks occur in Central Juu and Damin.
14. Multiple Articulations at Same Position: Most languages with retroflex sounds typically have only one retroflex sound with a given manner of articulation. An exception, however, is the Toda language, with a two-way distinction among retroflex sibilants between apical postalveolar and subapical palatal.

References

- Breeze, M. (1988): Phonological Features in Gimira and Dizi, in: *Cushitic – Omotic: Papers from the International Symposium on Cushitic and Omotic Languages Editors: Bechhaus-Gerst, M., and F. Serzisko* **Helmut Buske Verlag** Hamburg, Germany
- Esling. J. (2010): Phonetic Notation, in: *The Handbook of Phonetic Sciences 2nd Edition Editors: Hardcastle, W. J., J. Laver, and F. E. Gibbon* **Wiley-Blackwell** Hoboken, NJ
- Gowda, K. S. G. (1972): *Ao-Naga Phonetic Reader* **Central Institute of Indian Languages** Mysore, India
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of the World's Languages* **Blackwell** Oxford, UK
- Laver, J. (1994): *Principles of Phonetics* **Cambridge University Press** Cambridge, UK
- Maddieson, I., and S. F. Disner (1984): *Patterns of Sounds* **Cambridge University** Cambridge, UK
- Wikipedia (2021): Retroflex Consonant

Nasal Consonant

Overview

1. <u>Definition of the Nasal Consonant</u>: A *nasal*, also called a *nasal occlusive* or *nasal stop*, in contrast with an oral stop or nasalized consonant, is an occlusive consonant produced with a lowered velum, allowing air to escape freely through the noise (Wikipedia (2021)).
2. <u>Fraction of Nasals among Consonants</u>: The vast majority of consonants are oral consonants. Examples of nasals in English are [n], [ŋ], and [m], in words such as *nose*, *bring*, and *month*.
3. <u>Universality of Nasals in Languages</u>: Nasal occlusives are nearly universal in human languages. There are also other kinds of *nasal consonants* in some languages.

Definition

1. <u>Most Nasal Consonants are Occlusives</u>: Nearly all nasal consonants are nasal occlusives, in which air escapes through the nose but not through the mouth, as it is blocked/occluded by the lips or the tongue. The oral cavity still acts as a resonance chamber for the sound. Rarely, non-occlusive consonants may be nasalized.
2. <u>Voiced Nature of Nasal Consonants</u>: Most nasals are voiced, and in fact, sounds [n] and [m] are among the most common sounds cross-linguistically. Voiceless nasals occur in a few languages such as Burmese, Welsh, Icelandic, and Guarani.

3. Contrast with the Oral Consonants: This compares with oral stops, which block off the air completely, and fricatives, which obstruct the air with a new channel. Both stops and fricatives are more commonly voiceless than voiced, and are known as obstruents.
4. Nasal Sonorant Plus Oral Obstruent: In terms of acoustics, nasals are sonorants, which means that they do not significantly restrict the escape of air, as it can freely escape out the nose. However, nasals are also obstruents in their articulation because the flow of air through the mouth is blocked.
5. Duality in Nasal Consonant Behavior: This duality, a sonorant airflow through the nose along with an obstruction in the mouth, means that nasal occlusives behave both like sonorants and like obstruents. For example, nasals tend to pattern with other sonorants such as [r] and [l], but in many languages, they may develop from or into stops.
6. Acoustic Frequency Range of Nasals: Acoustically, nasals have bands of energy at round 200 and 2000 Hz.
7. IPA Table of Nasal Consonants: PS: The symbol <n> is commonly used to present the dental nasal as well, rather than <n̪>, as it is rarely distinguished from the alveolar nasal.
    a. Voiced/Voiceless Bilabial – m | m̥
    b. Voiced/Voiceless Labiodental – ɱ | ɱ̊
    c. Voiced/Voiceless Dental – n̪ | n̪̊
    d. Voiced/Voiceless Alveolar – n | n̥
    e. Voiced/Voiceless Retroflex - ɳ | ɳ̊
    f. Voiced/Voiceless Palatal - ɲ | ɲ̊
    g. Voiced/Voiceless Velar – ŋ | ŋ̊
    h. Voiced/Voiceless Uvular - ɴ | ɴ̥
8. Voiced Retroflex Nasals of India: The voiced retroflex nasal is [ɳ] is a common sound in Languages of India.
9. Voiced Palatal Nasals of Europe: The voiced palatal nasal [ɲ] is a common sound in European languages, such as: Spanish <ñ>, French and Italian <gn>, Catalan and Hungarian <ny>, Czech and Slovak <ň>, Polish <n accent>, Occitan and Portuguese <nh>, and – before a vowel – Modern Greek <νι>.

10. Nasals in Germanic/Chinese Languages: Many Germanic languages, including German, Dutch, English, and Swedish, as well as varieties of Chinese such as Mandarin and Cantonese, have [m], [n], and [ŋ].
11. Six-fold Nasals in Tamil: Tamil has a six-fold distinction between [m], [n̪], [n], [ɳ], [ɲ], and [ŋ].
12. Nasals in the Nuosu Language: The Nuosu language also contrasts six categories of nasals [m], [n], [m̥], [n̥], [ɲ], and [ŋ]. They are represented in Romanization by m, n, hm, hn, ny, and ng. Nuosu also contrasts nasalized stops and affricates with their voiced, unvoiced, and unaspirated versions.
13. Nasals in South European Languages: Catalan, Occitan, Spanish, and Italian have [m], [n], [ɲ] and phonemes, and [ɱ] and [ŋ] as allophones. Nevertheless, in several American dialects of Spanish, there is no palatal nasal but only a palatalized nasal, [n^j], as in English *canyon*.
14. Nasals in Brazilian/Angolan Portuguese: In Brazilian Portuguese and Angolan Portuguese [ɲ], written <nh>, is typically pronounced as [j̃], a nasal palatal approximant, a nasal glide – in Polish, this feature is also possible as an allophone. Semivowels in Portuguese often nasalize before and always after nasal vowels, resulting in [j̃] and [w̃].
15. Nasals in West Iberian Languages: What would be code nasal occlusives in other West Iberian languages is only slightly pronounced before dental consonants. Outside this environment the nasality is spread over the vowel or becomes a nasal diphthong, e.g., *mambembe*, outside the final – only in Brazil, and *mantem* in all other Portuguese dialects.
16. Moraic Nasals in Japanese Languages: A Japanese syllabary in kana typically Romanized as *n* and occasionally as *m* can manifest as one of several different nasal consonants, depending upon what consonant follows it; this allophone, colloquially written in IPA as /ɴ/, is known as the moraic nasal, per the language’s moraic structure.
17. Voiceless Nasals in Welsh Language: Welsh has a set of voiceless nasals [m̥], [n̥], and [ɲ̊], which occur predominantly as a result of nasal mutation of their voiced counterparts [m], [n], and [ɲ].
18. Languages with Phonemic Uvular Nasal: The Mapos Buang language of New Guinea has a phonemic uvular nasal [ɴ] which contrasts with a velar nasal. It is extremely rare for a language to have [ɴ] as a phoneme.

19. <u>Yanyuwa with 7-way Nasal Distinction</u>: Yanyuwa is highly unusual in that it has a seven-way distinction between [m], [n̪], [n], [ɳ], [n̠] – palatoalveolar, [ŋ̟] – front velar, and [ŋ̠] – back velar. This may be the only language in existence that contrasts nasals at seven distinct point of articulation.
20. <u>Nasal Fricatives/Flaps/Glides/Vowels</u>: The term ‘nasal occlusive’ or ‘nasal stop’ is generally abbreviated to *nasal*. However, there are also nasalized fricatives, nasalized flaps, nasal glides, and nasal vowels, as in French, Portuguese, and Polish.
21. <u>IPA Nasal Vowels/Nasalized Consonants</u>: In the IPA, nasal vowels and nasalized consonants are indicated by placing a tilde ~ over the vowel or the consonant in question: French *sang* sã, Portuguese *bom* bõ.

Voiceless Nasals

1. <u>Languages with Phonemic Voiceless Occlusives</u>: A few languages have phonemic voiceless nasal occlusives. Among them are Icelandic, Faroese, Burmese, Jalapa Mazatec, Kildin Sami, Welsh, and Central African Yup’ik.
2. <u>Voiceless Nasals in Iaai Language</u>: Iaai of New Caledonia has an unusually large number of them, with /m̥ m̥ʷ n̪̊ ɳ̊ ɲ̊ ŋ̊/, along with a number of voiceless approximants.

Other Kinds of Nasal Consonants

1. <u>Pure Nasal Consonants versus Others</u>: Ladefoged and Maddieson (1996) distinguish pure nasal consonants, the nasal occlusives such as *m n ng* in which the airflow is purely nasal, from partial nasal consonants such as *prenasalized consonants* and nasal pre-stopped

consonants, which are nasal only for part of their duration, as well as from *nasalized consonants*, which have simultaneous oral and nasal airflow.

2. Occlusive and Non-occlusive Nasal Allophones: In some languages, such as Portuguese, a nasal consonant may have occlusive and non-occlusive consonants.
3. Nasal Occlusive: In general, may be one of the following. First, it can be a nasal occlusive, such as English *n*, *m*, and *ng*.
4. Nasal Approximant: It can be a nasal approximant, as in *nh* in some Portuguese dialects.
5. Nasal Flap: It can be a nasal flap, such as nasal retroflex lateral flap in Pashto.
6. Prenasalized Consonants and Pre/post Stopped Nasals
7. Nasal Clicks: such as Zulu *nq, nx,* and *nc*
8. Other Nasalized Consonants: such as nasalized fricatives.

Languages without Nasals

A few languages, perhaps 2%, contain no phonemically distinct nasals (Maddieson (2008)). This led Ferguson (1963) to assume that all languages have at least one primary nasal occlusive. However, there are exceptions.

Lack of Phonemic Nasals

1. Languages that Lack Nasals Altogether: When a language is claimed to lack nasals altogether, as with several Niger-Congo languages or with the Pirãha language of the Amazon, nasal and non-nasal prenasalized consonants alternate allophonically, and it is a theoretical claim on the part of the individual linguist that the nasal is not the basic form of the consonant.

2. Geography of the Niger-Congo Languages: These languages lie in a band from Western Liberia to southeastern Nigeria, and north to southern Burkina. They include (Heine and Nurse (2000)).
3. Liberia: Kpelle – Mande family; Grebo, Kao - Kuu family
4. Burkina Faso: Gwamu - Gur family
5. Ivory Coast: Dan, Guro-Yaoure, Wan-Mwan, Gban/Gagu, Tura – all Mande family; Senadi/Senufo – Gur family; Nyabwa, We – Kru family; Ebrie, Avikam, Abure - Kwa family
6. Ghana: Abron, Akan, Ewe - Kwa family
7. Benin: Gen, Fon - Kwa family
8. Nigeria: Mbaise Igbo, Ikwere - Igboid family
9. CAR: Yakoma - Ubangi family
10. Nasals in Niger-Congo Languages: In the case of some Niger-Congo languages, for example, nasals occur before only nasal vowels. Since nasal vowels are phonemic, it simplifies the picture somewhat to assume that nasalization in occlusives is allophonic.
11. Nasalizing Oral/Denasalizing Nasal Occlusives: There is then a second step in claiming that vowels nasalize oral occlusives, rather than oral vowels denasalizing nasal occlusives, that is, whether [mã, mba] are phonemically /mbã, mba/ without full nasals, or /mã, ma/ without prenasalized stops.
12. Corresponding Non-uniqueness of Nasals: Postulating underlying oral or prenasalized stops rather than true nasals helps explain the apparent instability of nasal correspondences throughout Niger-Congo languages compared with, for example, Indo-European (Williamson (1989)).
13. Consequences of the above Analysis: The above analysis comes at the expense, in some languages, of postulating either a single nasal consonant that can only be syllabic, or a larger set of nasal vowels that oral vowels, both typologically odd situations.
14. Example of Wukari Language: The way such a situation could develop is illustrated by the Jukunoid language, Wukari. Wukari allows the oral vowels in syllables like *ba, mba*, and nasal vowels in bã, mbã, suggesting that nasals become prenasalized stops before oral vowels. Historically, however, *mb became *mm before nasal vowels, and then reduced to *m, leaving the current asymmetric distribution (Hyman (1975)).

15. [l] and [n] in Tlingit: Among older speakers of the Tlingit language, [l] and [n] are allophones. Tlingit is usually described as having an unusual, perhaps unique lack of /l/ despite having five lateral obstruents; the older generation could be argued to have /l/ but at the expense of having no nasals.

Lack of Phonetic Nasals

1. Nasals in Puget Sound Languages: Several of the languages surrounding Puget Sound, such as Quileute of the Chimakuan family, Lushootseed of the Salishan family, and Makah of the Wakashan family, are truly without any nasalization whatsoever, in consonants of vowels, except in special speech registers such as baby talk of the archaic speech of mythological figures – and perhaps not even that in the case Quileute.
2. Migration from Nasals to Bilabials: This is an areal feature, only a few hundred years old, where nasals became nasal stops, i.e., [m] became [b], etc., after colonial contact. For example, "Snohomish" is currently pronounced *sdohonish*, but was transcribed in nasals in the first English-language records.
3. Nasals in Melanesian Languages: The only other place in the world where this is known to occur is in Melanesia. In the central dialect of the Rotokas language of the Bougainville Island, nasals are only used when imitating foreign accents; a second dialect, however, has a series of nasals. The Lakes Plain languages of West Irian are similar.
4. Migration to Labials and Alveolars: The unconditioned loss of nasals, as in Puget Sound, is unusual. However, in Korean, word-initial /m/ and /n/ are shifting to [b] and [d].
5. Trajectory of Migration in Koran: This started out in the non-standard dialects and was restricted to the beginning of prosodic units – a common position for fortition – but has expanded to many speakers of the standard language to the beginning of common words even within prosodic units (Yoshida (2008)).

References

- Ferguson, C. A. (1963): *Assumptions about Nasals: A Sample Study in Phonological Universals* **De Gruyter** Berlin, Germany
- Heine, B., and D. Nurse (2000): *African Languages: An Introduction* **Cambridge University Press** Cambridge, UK
- Hyman, L. M. (1975): Nasal States and Nasal Processes
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Maddieson, I. (2008): Absence of Common Consonants
- Wikipedia (2021): Nasal Consonant
- Williamson, K. (1989): Niger-Congo Overview, in: *The Niger-Congo Languages: A Classification and Description of Africa's Largest Language Family (Editors: Bendor-Samuel, J. T. and R. L. Hartell)* **University Press of America** Lanham, MD
- Yoshida, K. (2008): Phonetic Implementation of Korean "Denasalization" and its Variation Related to Prosody

Manner of Articulation

Overview

1. Defining the Manner of Articulation: In articulatory phonetics, the *manner of articulation* is the configuration and the interaction of articulators, i.e., speech organs such as tongue, lips, and palate, when making a speech sound (Wikipedia (2021)).
2. Parameters Determining the Manner of Articulation: One parameter is *stricture*, that is, how closely the speech organs approach one another. Other include those involved in the *r*-like sounds – taps and trills – and the siblancy of fricatives.
3. Impact on Consonants and Vowels: The concept of manner is mainly used in the discussion of consonants, although the movement of the articulators will also greatly alter the properties of the vocal tract, thereby changing the formant structure of speech sounds that is crucial for the identification of vowels.
4. Place of Articulation and Degree of Phonation: For consonants, the place of articulation and the degree of phonation of voicing are considered separately from manner, as being independent parameters.
5. Homorganic Consonants - Nasality and Laterality: Homorganic consonants, which have the same place of articulation, may have different manners of articulation. Often, nasality and laterality are included in manner, but some phoneticians, such as Peter Ladefoged, consider them to be independent.

Broad Classifications

1. Obstruents - Substantial Obstruction of Airflow: Manner of articulation with substantial obstruction of airflow, such as stops, fricatives, and affricates, are called *obstruents*. These are prototypically voiceless, but voiced obstruents are extremely common as well.
2. Sonorants - No Obstruction to Airflow: Manners without such obstructions, i.e., nasals, liquids, and approximants, and also vowels, are called *sonorants* because they are nearly always voiced.
3. Voiceless Sonorants - Instances of Occurrence: Voiceless sonorants are uncommon, but are found in Welsh and classical Greek – the spelling "rh", in Standard Tibetan – the "lh" of Lhasa, and the "wh" in those dialects of English that distinguish "which" from "witch".
4. Distinction between Sonorants and Resonants: Sonorants may also be *resonants*, and some linguists prefer that term, restricting the word 'sonorant' to non-voccoid resonants, that is, nasals or liquids, but not vowels or semivowels.
5. Classification as Occlusives and Continuants: Another common distinction is between *occlusives* – stops, nasals, and affricates, and *continuants* – all else.

Stricture

1. Classifying Sounds on a Cline: From greatest to least stricture, speech sounds may be classified alone a cline as: stop consonants, i.e., with *occlusion* or blocked airflow; fricative consonants – with partially blocked and therefore strongly turbulent airflow; approximants with only slight turbulence; and vowels with fully unimpeded airflow.
2. Affricates from Stops and Fricatives: Affricates often behave as if they were intermediate between stops and fricatives, but phonetically they are sequences of a stop and a fricative.
3. Migration along Cline - Lenition/Fortition: Over time, sounds in a language may move along the cline towards less stricture in a process called lenition or towards more stricture in a process called fortition.

Other Parameters

1. Distinguishing Sibilants from other Fricatives: Sibilants are distinguished from other fricatives by the shape of the tongue and how the airflow is directed over the teeth. Fricatives at coronal places of articulation may be sibilant or non-sibilant, sibilants being the more common.
2. Nature of Flaps and Taps: Flaps – also called taps – are similar to very brief stops. However, their articulation and behavior are distinct enough to be considered a separate manner, rather than just length.
3. Distinction between Flaps and Stops: The main articulatory difference between flaps and stops is that, due to the greater length of stops compared to flaps, a build-up of air pressure occurs behind a stop which does not occur behind a flap. This means that when the stop is released, there is a burst of air as the pressure is relieved, while for flaps there is no such burst.
4. Trills from Speech Organ Vibration: Trills involve the vibration of one of the speech organs. Since trilling is a separate parameter from the stricture, the two may be combined. Increasing the stricture of a typical trill results in a trilled fricative. Trilled affricates are also known.
5. Nasalization as an Independent Parameter: Nasal airflow can be added as an independent parameter to any speech sound. It is most commonly found in nasal occlusives and nasal vowels, but nasalized stops, fricatives, and approximants are also found. When a sound is not nasal, it is called *oral*.
6. Laterality - Sideways Release of Airflow: Laterality is the release of the airflow at the side of the tongue. This can be combined with other manners resulting in lateral approximants – such as the pronunciation of the letter L in the English word “let”, lateral flaps, and lateral fricatives and affricates.

Individual Manners

1. Stop: *Stop*, often called a plosive, is an oral occlusive, has *occlusion*/blocking of the vocal oral tract, and no nasal airflow, so the airflow stops completely. Examples include English /p t k/ - voiceless, and /b d g/ - voiced.
2. Stop Onset and Release: If the consonant is voiced, the voicing is the only sound made during occlusion; if it is voiceless, a stop is completely silent. What we hear as a /p/ or a /k/ is the effect that the *onset* of the occlusion has on the preceding vowel, as well as the release burst and its effect on the following vowel.
3. Places of Articulation in Stops: The shape and the position of the tongue, i.e., the *place* of articulation, determines the resonant cavities that gives different stops their characteristic sounds. All languages have stops.
4. Nasal: *Nasal* is a nasal occlusive, where there is an occlusion of the oral tract, but air passes through the nose. The shape and the position of the tongue determine the resonant cavity that gives different nasals their characteristic sounds. Examples include English /m, n/.
5. Occurrence of Nasals in Languages: Nearly all languages have nasals, the only exception being in the area of Puget Sound and a single language in Bougainville Island.
6. Fricatives: *Fricatives*, sometimes called *spirants*, are consonants where there is a continuous *frication* – turbulent and noisy airflow – at the place of articulation. Examples include /f, s/ - voiceless – and /v, z/ - voiced, etc.
7. Occurrence of Fricatives in Languages: Most languages have fricatives, though many have only an /s/. However, the indigenous Australian languages are devoid of fricatives of any kind.
8. Sibilants: *Sibilants* are a type of fricative where the airflow is guided by a groove in the tongue toward the teeth, creating a high-pitched and a very distinctive sound. They are by far the most common fricative.
9. Fricatives at Coronal Places of Articulation: Fricatives at coronal – front of tongue – places of articulation are usually, though not always, sibilants. English sibilants include /s/ and /z/.
10. Lateral Fricatives: *Lateral fricatives* are a rare type of fricative, where the frication occurs at one or both sides of the edge of a tongue. The *ll* of Welsh and the *hl* of Zulu are both lateral fricatives.

11. Affricates: *Affricates* begin like a stop, but then release into a fricative rather than having a separate release of their own. The English letters "ch" [t integral below curly bow above] and 'j' [(d z) curly bow above] represent affricates. Affricates are quite common around the world, though less common than fricatives.
12. Flap: *Flap,* often called a *tap,* is a momentary closure of the oral cavity. The *tt* of *utter* and the *dd* of *udder* are pronounced as a flap [left stem snipped r] in North American and Australian English.
13. Distinction between Tap and Flap: Many linguists distinguish *taps* from *flaps*, but there is no consensus on what the difference might be. No language relies on such a difference. There are also *lateral flaps*.
14. Trill: *Trill* is a consonant in which the articulator – usually the tip of the tongue – is held in place, and the airstream causes it to vibrate. The double "r" in Spanish "perro" is a trill. Trills and flaps, where there are one or more brief occlusions, constitute a class consonants called *rhotics*.
15. Approximant: *Approximants* are consonants where there is very little obstruction. Examples include English /w/ and /r/. In some languages, such as Spanish, there are sounds that seem to fall between a *fricative* and an *approximant*.
16. Semivowel: One use of the word *semivowel*, sometimes called a *glide*, is a type of approximant, pronounced like a vowel but with the tongue closer to the roof of the mouth, so that there is a slight turbulence.
17. Usage of the Term Semivowel: In English, /w/ is the semivowel equivalent of /u/, and /j/ - spelt *y* – is the semivowel equivalent of the vowel /i/ in this usage. Other descriptions use *semivowel* for vowel-like sounds that are not syllabic, but do not have the increased stricture of the approximants. These are found as elements in diphthongs. The word may also be used to cover both concepts.
18. Glide: The term *glide* is newer than *semivowel*, being used to indicate an essential quality of sounds /w/ and /j/, which is the movement – or *glide* – from their initial position - /u/ and /i/, respectively – to a following vowel.
19. Lateral Approximants: *Lateral approximants*, usually shortened to *laterals*, are a type of approximant pronounced with the side of the tongue. English /l/ is a lateral. Together with

rhotics, which have similar behavior in many languages, these form a class of consonants called *liquids*.

Other Airstream Initiations

1. Pulmonic Egressive Airstream Mechanism: All of these manners of articulation are pronounced with an airstream mechanism called pulmonic egressive, meaning that air flows outward, and is powered by the lungs – actually the ribs and the diaphragm. Other airstream mechanisms are possible. Sounds that rely on some of these follow in this section.
2. Ejectives, which are Glottalic Egressive: Here, the airstream is powered by the upward movement of the glottis rather than by the lungs or the diaphragm. Stops, affricates, and occasionally fricatives may occur as ejectives. All ejectives are voiceless, or at least transition from voiced to voiceless.
3. Implosives, which are Glottalic Ejectives: Here, the glottis moves downwards, but the lungs may be used simultaneously to provide voicing, and in some language no air may actually flow into the mouth. Implosive stops are not uncommon, but implosive stops and affricates are rare. Voiceless implosives are also rare.
4. Clicks, which are Lingual Ingressive: Here, the back of the tongue is used to create a vacuum in the mouth, causing air to rush in when the forward occlusion – tongue or lips – is released. Clicks may be oral or nasal, stops or affricate, central or lateral, voiced or voiceless. They are extremely rare in normal words outside Southern Africa. However, English has a click in its “tsk tsk” – or “tut tut” – sound, and another is often used to say “giddy up” to a horse.
5. Linguopulmonic and Linguoglottalic Combination Consonants: Combinations of these, in some analysis, occur in a single consonant: *linguopulmonic* or *linguoglottic – ejective –* consonants, with clicks released into either a pulmonic or an ejective stop/fricative.

References

- Wikipedia (2021): Manner of Articulation

Obstruent

Overview

1. Definition of an Obstruent: An obstruent is a speech sound such as [k], [d͡ʒ], or [f] that is formed by *obstructing* the airflow (Wikipedia (2021)).
2. Contrasting Obstruents with Sonorants: Obstruents contrast with sonorants, which have no obstruction and so resonate (Gussenhoven and Haike (2017)). All obstruents are consonants, but sonorants include both vowels and consonants.

Subclasses

Obstruents are divided into plosives/oral stops – such as [p, t, k, b, d, g], with complete occlusion of the vocal tract, often followed by a release burst; fricatives – such as [f, s, ʃ, x, v, z, ʒ, ɣ] with limited closure, not stopping airflow, but making it turbulent; and affricates – which begin with complete occlusion but the release into a fricative-like release, such as [t͡ʃ] and [d͡ʒ] (Zsiga (2013)).

Voicing

Obstruents are prototypically voiceless, but voiced obstruents are common. This contrasts with sonorants, which are prototypically voiced and only rarely voiceless.

References

- Gussenhoven, C., and J. Haike (2017): *Understanding Phonology 4th Edition* **Routledge** Oxfordshire, UK
- Wikipedia (2021): Obstruent
- Zsiga, E. (2013): *The Sounds of Language: An Introduction to Phonetics and Phonology* **Wiley-Blackwell** Hoboken, NJ

Occlusive

Overview

1. Definition/Characteristics of an Occlusive: An *occlusive*, sometimes known as a *stop*, is a consonant sound produced by occluding, i.e., blocking, airflow in the vocal tract, but not necessarily in the nasal tract. The duration of the block is the *occlusion* of the consonant. An occlusive may refer to one or more of the following, depending on the author (Wikipedia (2021)).
2. Stops/Oral Stops/Plosives: *Stops*, or more precisely *oral stops* – also known as *plosives* – are oral occlusives, where the occlusion of the oral tract stops all airflow – oral and nasal. Examples in English are the voiced /b/, /d/, /g/ and the voiceless /p/, /t/, /k/.
3. Nasals/Nasal Stops: *Nasals,* also known as *nasal stops,* are nasal occlusives where the occlusion of the vocal tract shifts the airflow to the nasal tract. Examples in English are /m/, /n/, and /ŋ/.
4. Affricates: Affricates such as // and // are partial occlusives. Typically *stops* and *affricates* are contrasted, but affricates are also described as *stops with fricative release,* contrasting with *simple stops,* i.e., plosives.
5. Implosives: Here the airstream differs from typical stops and affricates – no examples in English.
6. Ejectives: These are yet another airstream – no examples in English.
7. Click Consonants: Such as the exclamation *tsk! tsk!* made when expressing reproach – often humorously – or pity, are double occlusives with yet another airstream mechanism. They may be oral occlusives, nasals, affricates, or ejectives.

8. Restricted Usage of *Oral Occlusives*: *Oral occlusives* may mean any one of the above apart from nasal occlusives, but typically means stop/plosive. *Nasal occlusive* may be used to distinguish the simple nasal sounds from other nasal consonants.
9. Inconsistent Use of Stop/Occlusive: The terms *stop* and *occlusive* are used inconsistently in the literature. They may be synonyms, or they may distinguish nasality as shown here. However, some authors use them in the opposite sense to here, with *stop* being the generic term – *oral stop, nasal stop*, etc. – and *occlusive* being restricted to oral consonants.
10. View of Ladefoged and Maddieson: Ladefoged and Maddieson (1996) prefer to distinguish *stop* from *nasal*. They say: "Note that what we call simply nasals are called nasal stops by some linguists. We avoid this phrase, preferring to reserve the term *stop* for sounds in which there is a complete interruption of the airflow."

Common Occlusives

1. Occurrence of Oral/Nasal Stops: All languages in the world have occlusives (Konig (1978)) and must have at least the voiceless stops [p], [t], and [k] and the nasals [n] and [m]. However, there are exceptions.
2. Stability of the Labial Plosive: Colloquial Samoan lacks the coronals [t] and [n], and several North American languages, such as the northern Iroquoian languages, lack the labials [p] and [m]. In fact, the labial plosive is the least stable of the voiceless stops in the languages of the word, as the unconditioned sound change [p] → [f] → (→ [h] → *Φ*) is quite common in unrelated languages, having occurred in the history of Classical Japanese, Classical Arabic, and Proto-Celtic, for instance.
3. Environmental Absence/Morphing of Nasals: Some of the Chimakuan, the Salishan, and the Wakashan languages near Puget Sound lack nasal occlusives [m] and [n], as does the Rotokas language of Papua New Guinea. In some African and South American languages, nasal occlusives occur only in the environment of nasal vowels and so are not distinctive.

4. Occurrence in Samoan and Hawaiian: Formal Samoan has two nasals /n ŋ/ and /t/ but only one word with velar [k]; colloquial Samoan conflates these to /ŋ k/. Ni'ihau Hawaiian has [t] for /k/ to a greater extent than Standard Hawaiian, but neither distinguishes a /k/ from a /t/. It may be mor accurate to say that Hawaiian and Samoan do not distinguish velar and coronal stops than to say they lack one or the other.

References

- Konig, W. (1978): Dtv – Atlas zur Deutschen Sprache: Tafeln u. Texte **Deutscher Taschenbuch Verlag** Munich, Germany
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Wikipedia (2021): Occlusive

Plosive

Overview

1. Phonetic Definition of a Plosive: A *plosive*, also known as an *occlusive* or simply a *stop*, in a pulmonic consonant in which the vocal tract is blocked so that all airflow ceases (Wikipedia (2021)).
2. Tongue Tip/Blade/Body, Lips, Glottis: The occlusion may be made with the tongue tip or blade – [t] and [d], tongue body – [k] and [g], lips – [p] and [b], or glottis [ʔ].
3. Contrasting Plosives with Nasals: Plosives contrast with nasals, where the vocal tract is blocked but the airflow continues through the nose, as in /m/ and /n/, and with fricatives, where partial occlusion impedes but does not block the airflow.

Terminology

1. Inconsistent Use of Stop/Occlusive/Plosive: The terms *stop*, *occlusive*, and *plosive* are often used interchangeably. Linguists who distinguish them may not agree on the distinction being made.
2. Distinction between Stops and Occlusives: The terms refer to different features of the consonant. *Stop* refers to the airflow that is stopped. *Occlusive* refers to the articulation, which occludes/blocks the vocal tract.
3. Characteristics of Plosives and Applosives: *Plosive* refers to a consonant with an release burst/plosion. Some object to the term *plosive* for inaudibly released stops, which may

instead be called *applosives*. The International Phonetics Association and the International Clinical Phonetics and Linguistics Association use the term *plosive*.

4. Combining Nasal and Oral Occlusives: Either *occlusive* or *stop* may be used as a general term covering the other together with nasals. That is, *occlusive* may be defined as oral occlusives – plosives and affricates, plus nasal occlusives – nasals such as [m] and [n], or *stops* may be defined as oral stops/plosives plus nasal stops/nasals.
5. Terminology of Ladefoged and Maddieson: Ladefoged and Maddieson (1996) prefer to restrict *stop* t non-oral occlusives. They say: "What we simply call nasals are called nasal stops by some linguists. We avoid this term, preferring to reserve the term *stop* for sounds I which there is a complete interruption of airflow." In addition, they restrict *plosive* to pulmonic consonants; *stops* in their usage includes ejective and implosive consonants.
6. Use of Plosive for Glottals: If a term such as *plosive* is used for oral non-affricated obstruents, and nasals are not nasal stops, then a *stop* may mean a glottal stop; *plosive* may even mean non-glottal stop. In other cases, however, it may be the word *plosive* that is restricted to the glottal stop.
7. Plosives without a Release Burst: Note that, generally speaking, plosives do not have a plosion – release burst. In English, for example, there are plosives with no audible release, such as the /p/ in *apt*. However, English plosives do have plosion in other environments.
8. Greek Terminology for Plosives: In ancient Greek, the term for plosive was *aphonon*, which means *unpronounceable*, *voiceless*, or *silent*, because plosives could not be pronounced without a vowel. The term was calqued into Latin as *muta*, and from there borrowed into English as *mute*.
9. Morphing of *Plosive* into *Mute/Surd*: *Mute* was sometimes used instead for voiceless consonants, whether plosives or fricatives, a usage that was later replaced with *surd*, from Latin *surdus* – *deaf* or *silent*, a term still occasionally seen in the literature.

Articulation

1. Articulation Phases in a Plosive: A plosive is typically analyzed as having up to three phases:
   a. Approach, during which the articulators come together
   b. Hold – or *occlusion* or *closure,* during which the articulators are held and block the airstream
   c. Release – or *burst* or *plosion*, when the articulators are separated, and compressed air is released (Collins and Mees (2013))
2. Lack of the Approach Phase: Only the hold phase is requisite. A plosive may lack an approach when it is preceded by a consonant that involves an occlusion at the same place of articulation, as in [d], in *end* or *old.*
3. Lack of Release-Burst Phase: In many languages, such as Malay and Vietnamese, word-final plosives lack a release-burst even when followed by a vowel, or have a nasal release.
4. Similarity with Nasal Occlusives: Nasal occlusives are somewhat similar. In the catch and hold, airflow continues through the nose; in the release, there is no burst, and final nasals are typically unreleased across most languages.
5. Affricates containing Plosive-Fricative Contours: In affricates, the catch and hold are those of a plosive, but the release is that of a fricative. That is, affricates have plosive-fricative contours.

Common Plosives

All spoken natural languages in the world have plosives (Konig (1994)), and most have at least the voiceless plosives [p], [t], and [k].

Classification – Voice

1. Vocal Cords in Voiced Plosives: *Voiced plosives* are pronounced with the vibration of the vocal cords, *voiceless plosives* without.
2. Frequency of Voiced/Voiceless Plosives: Plosives are commonly voiceless, and many languages such as Mandarin Chinese and Hawaiian, have only voiceless plosives. Others, such as most Australian languages, are indeterminate: plosives may vary between voiced and voiceless without distinction.

Classification – Aspiration

1. Vocal Cords in Aspirated Plosives: In *aspirated plosives*, the vocal cords/folds are abducted at the time of release.
2. Breathy Voice in Prevocalic Aspiration: In prevocalic aspirated plosive, i.e., a plosive followed by a vowel or a sonorant, the time when the vocal cords begin to vibrate will be delayed until the vocal cords come together enough for voicing to begin, and will usually start with breathy voicing.
3. Voice Onset Time/Aspiration Interval: The duration between the release of a plosive and the voice onset is called the *voice onset time* VOT or the *aspiration interval*.
4. Highly Aspirated Plosive - Longer VOT: Highly aspirated plosives have a longer period of aspiration, so that there is a long period of voiceless airflow – a phonetic [h] – before the onset of the vowel.
5. Tenuis Plosive with Low VOT: In tenuis plosives, the vocal cords come together for voicing immediately following the release, and there is little to no aspiration, i.e., the voice onset time is close to zero.
6. Brief Segment of Breathy Voice: In English, there may be a brief segment of breathy voice that identifies the plosive as voiceless and not voiced.
7. Voiced Plosive Vocal Fold Vibration: In voiced plosives, the vocal folds are set for voicing before the release, and often vibrate during the entire hold, and in English, the voicing after release is not breathy.

8. Definition of Fully Voiced Plosive: A plosive is called *fully voiced* if it is voiced during the entire occlusion.
9. Plosives with Slightly Delayed Voicing: In English, however, initial voiced plosives like /#b/ or /#d/ may have no voicing during the period of occlusion, or the voicing may start shortly before the release and continue after the release, and word-final plosives tend to be fully devoiced.
10. Devoicing in Voiced Plosive - Examples: In most dialects of English, the final /b/, /d/, and /g/ in words like *rib*, *mad*, and *dog* are fully devoiced (Cruttenden (2014)).
11. Aspiration Scenarios in Voiceless Plosives: Initial voiceless plosives like *p* in *pie* are aspirated, with a palpable puff of air upon release, whereas a plosive after a *s*, as in *spy*, is tenuis/unaspirated.
12. Flickering of Flame under Aspiration: When spoken near a candle flame, the flame will flicker more after the words *par*, *tar*, and *car* are articulated, compared with *spar*, *star*, and *scar*. In the most common pronunciation of *papa*, the initial *p* is aspirated whereas the medial *p* is not.

Length

1. Definition of a Geminate/Long Consonant: In a geminate or a *long* consonant, the occlusion lasts longer than in simple consonants.
2. Distinguishing Plosives only by Length: In languages where plosives are distinguished only by length, e.g., Arabic, Ilwana, and Icelandic, the long plosives may be held up to three times as long as the short plosives.
3. Geminate Plosive Example in Italian: Italian is well known for its geminate plosives, as the double *t* in the name *Vittoria* takes just as long to say at the *ct* does in English.
4. Geminate Plosive Example in Japanese: Japanese also prominently features geminate consonants, such as in the minimal pair *kita* ‘came’ and *kitta* ‘cut’.

5. Reinforce Voicing, Aspiration, and Length: Note that there are many languages where the features voice, aspiration, and length reinforce each other, and in such cases, it may be hard to determine which of these features predominates.
6. Use of Fortis and Lenis: In such cases, the term fortis is used for aspiration and gemination, where lenis is used for single, tenuous, or voiced plosives. Be aware that the terms *fortis* and *lenis* are poorly defined, and their meanings vary from source to source.

Nasalization

1. Lowered Velum in Simple Nasals: Simple nasals are differentiated from plosives only by a lowered velum that allows the air to escape through the nose during the occlusion.
2. Acoustically Sonorant but Articulatorily Obstruent: Nasals are acoustically sonorants, as they have a non-turbulent airflow, and are always nearly voiced, but they are articulatorily obstruents, as there is a complete blockage of the oral cavity. The term occlusive may be used as a cover term for both nasals and plosives.
3. Prenasalized Stop with Lowered Velum: A prenasalized stop starts out with a lowered velum that rises during the occlusion.
4. Prenasalized Stop Example in English: The closest examples in English are the consonant clusters such as the [nd] in *candy*, but many languages have prenasalized stops that function phonologically as single consonants.
5. Prenasalized Stops in other Languages: Swahili is well known for having words beginning with prenasalized stops, as in *ndege* 'bird', and in many languages of the South Pacific, such as Fijian, these are spelt with single letters *b* [mb], *d* [nd].
6. Post-nasalized Plosive with Raised Velum: A post-nasalized plosive begins with a raised velum that lowers during occlusion.
7. Post-nasalized Plosive Examples in English: This causes an audible, nasal release, as in English *sudden*. This could be compared to the /dn/ cluster found in Russian and other Slavic languages, which can be seen in the name of the Dneiper River.

8. Phonemic Nature of Pre-nasalization/Post-nasalization: Note that the terms *pre-nasalization* and *post-nasalization* are normally used only in languages where the sounds are phonemic: that is, not analyzed into sequences of plosives plus nasal.

Airstream Mechanism

1. Pulmonic Egressive Airstream Mechanism: Stops may be made with more than one air-stream mechanism. The normal mechanism is pulmonic egressive, that is, with the air flowing outward from the lungs.
2. Ejective, Implosive, or Click Airstreams: All languages have pulmonic stops. Some languages have stops with other mechanisms as well: ejective stops with glottalic egressive, implosive stops with glottalic ingressive, or click consonants with lingual ingressive.

Tenseness

1. Muscular Tension in Fortis Plosive: A *fortis plosive* is produced with more muscular tension than a *lenis plosive*. However, this is difficult to measure, and there is usually debate over the actual mechanism of alleged fortis or lenis consonants.
2. Plosives with Contracted Glottis in Korean: There are a series of plosives in the Korean language, sometimes written with the IPA symbol for ejectives, which are produced using a *stiff voice*, meaning there is increased contraction of the glottis compared with normal production for voiceless plosives.
3. Stiff Voice in the Following Vowels: The indirect evidence for stiff voice is in the following vowels, which have a higher fundamental frequency than those following other plosives. The higher frequency is explained as a result of the glottis being tense.

4. Use of Additional Phonation: Other such phonation types include breathy voice, or murmur; slack voice; and creaky voice.

Transcription

1. Dedicated Plosive Symbols in IPA: The following plosives have been given dedicated symbols in the IPA.
2. Symbols for Plosive Consonants:
   a. Voiceless/Voiced Bilabial Plosive: <p>/<b>
   b. Voiceless/Voiced Alveolar Plosive: <t>/<d>
   c. Voiceless/Voiced Alveolar Plosive: <ʈ>/<ɖ>
   d. Voiceless/Voiced Alveolar Plosive: <c>/<ɟ>
   e. Voiceless/Voiced Alveolar Plosive: <k>/<g>
   f. Voiceless/Voiced Alveolar Plosive: <q>/<ɢ>
   g. Epiglottal Plosive: <ʡ>
   h. Glottal Stop: <ʔ>

English

1. [p t k]: Voiceless, aspirated word-initially, tenuis in clusters after *s*, word-final often with no audible release.
2. [b d g]: Unaspirated, partially-voiced word-initially, fully voiced intervocalically, fully devoiced when word-final.
3. [ʔ]: Glottal stop, not as a phoneme in most dialects.

Variations

1. Transcriptions with Diacritics or Modifiers: Many subclassifications of plosives are transcribed by adding a diacritic or a modifier to the IPA symbols above.
2. Phonation and Voice Onset Time:
    a. Voiceless - <t>
    b. Voiced - <d>
    c. Tenuis - <t˭>
    d. Aspirated - <t^{h}>
    e. Breathy-voiced - <d̤>
3. Airstream Mechanism:
    a. Pulmonic Egressive - <t>/<d>
    b. Ejective - <tʼ>
    c. Implosive - <ɗ>
    d. Click - <!>
4. Nasality:
    a. Prenasalized - <^{n}d>
    b. Nasally Released - <d^{n}>
    c. Lenis: <d> with a voiceless Diacritic - <d̥>
    d. Tense - <t over double vertical pipes>
    e. Geminate - <tt dd> <t: d:>

References

- Collins, B., and I. M. Mees (2013): *Practical Phonetics and Phonology: A Resource Book for Students 3rd Edition* **Routledge** Oxfordshire, UK

- Cruttenden, A. (2014): *Gimson's Pronunciation of English 8th Edition* **Routledge** Oxfordshire, UK
- Konig, W. (1978): Dtv – Atlas zur Deutschen Sprache: Tafeln u. Texte **Deutscher Taschenbuch Verlag** Munich, Germany
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Wikipedia (2021): Plosive

Fricative

Overview

1. Mechanism for Production of Fricatives: *Fricatives* are consonants produced by forcing air through a narrow channel made by placing two articulators close together (Ladefoged and Maddieson (1996), Wikipedia (2021)).
2. Secondary Articulation for the Frication: These may be the lower lip against the upper teeth, as in the case [f]; the back of the tongue against the soft palate, as in the case of German [χ] – the final consonant of *Bach*; or the side of the tongue against the molars, in the case of Welsh [ɬ] – appearing twice in the name *Llanelli*. This turbulent airflow is called *frication*.
3. Definition of the Sibilant Subcategory: A particular subset of the fricatives are the *sibilants*. When forming a sibilant, one is still forcing air through a narrow channel, but in addition, the tongue is curled lengthwise to direct the air over the edge of the teeth (Ladefoged and Maddieson (1996)). English [s], [z], [ʃ], and [ʒ] are examples of sibilants.
4. Spirant - Outdated Term for Fricative: The use of two other terms is less standardized: *Spirant* is an older term for fricatives used by some American and European phoneticians and phonologists (Lodge (2009)).
5. Labiodental and Uvular Fricatives - Strident: *Strident* could just mean *sibilant*, but some authors include also labiodental and uvular fricatives in this class.

Types – Sibilants

1. <u>Voiceless Coronal Sibilant</u>: [s], as in English *sip*.
2. <u>Voiced Coronal Sibilant</u>: [z], as in English *zip*.
3. <u>Voiceless Dental Sibilant</u>: [s̪]
4. <u>Voiced Dental Sibilant</u>: [z̪]
5. <u>Voiceless Apical Sibilant</u>: [s̺]
6. <u>Voiced Apical Sibilant</u>: [z̺]
7. <u>Voiceless Pre-dorsal Sibilant</u>: [s̟] – laminal, with tongue tip at lower teeth (Pountain (2017))
8. <u>Voiced Pre-dorsal Sibilant</u>: [z̟] – laminal.
9. <u>Voiceless Postalveolar Sibilant</u>: [s̠]
10. <u>Voiced Postalveolar Sibilant</u>: [z̠]
11. <u>Voiceless Palatoalveolar Sibilant</u>: [ʃ̠] - domed, partially palatalized, as in English *ship*
12. <u>Voiced Palatoalveolar Sibilant</u>: [ʒ̠] – domed, partially palatalized, s the *si* in English *vision*
13. <u>Voiceless Alveolopalatal Sibilant</u>: [ɕ] – laminal, palatalized
14. <u>Voiced Alveolopalatal Sibilant</u>: [ʑ] – laminal, palatalized
15. <u>Voiceless Retroflex Sibilant</u>: [ʂ] – apical or subapical
16. <u>Voiced Retroflex Sibilant</u>: [ʐ] – apical or subapical
17. <u>Articulation Location(s) on the Tongue</u>: All sibilants are coronal, but within that range may be dental, alveolar, postalveolar, or palatoalveolar.
18. <u>Tongue-Shape Based Secondary Articulation</u>: However, at the postalveolar place of articulation, the tongue may take several shapes: domed, laminal, or apical, and each of these is given a separate symbol and a separate name.
19. <u>IPA Symbology Overlap with Retroflexes</u>: Prototypical retroflexes are subapical and palatal, but they are usually written with the same symbol as apical post-velars.
20. <u>Diacritic Based Apical/Laminal Distinction</u>: The alveolars and dentals may also be either apical or laminal, but this difference is indicated with diacritics rather than with separate symbols.

Central Non-sibilant Fricatives

1. Voiceless Bilabial Fricative: [ɸ]
2. Voiced Bilabial Fricative: [β]
3. Voiceless Labiodental Fricative: [f], as in English ***f**ine*.
4. Voiced Labiodental Fricative: [v], as in English ***v**ine*
5. Voiceless Linguolabial Fricative: [θ̼]
6. Voiced Linguolabial Fricative: [ð̼]
7. Voiceless Dental Non-Sibilant Fricative: [θ], [θ̝] – as in English ***th**ing*
8. Voiceless Dental Non-Sibilant Fricative: [ð], [ð̝] – as in English ***th**at*
9. Voiceless Alveolar Non-Sibilant Fricative: [θ-], [ɹ̝̊]
10. Voiced Alveolar Non-Sibilant Fricative: [ð̠], [ɹ̝]
11. Voiceless Trilled Fricative: [r̝̊]
12. Voiced Trilled Fricative: [r̝]
13. Voiceless Palatal Fricative: [ç]
14. Voiced Palatal Fricative: [ʝ]
15. Voiceless Velar Fricative: [χ]
16. Voiced Velar Fricative: [ɣ]
17. Voiceless Palatovelar Fricative: [ɧ (palatal-velar)] – articulation disputed
18. Voiceless Uvular Fricative: [χ]
19. Voiceless Pharyngeal Fricative: [ħ]
20. Voiceless Epiglottal Fricative: [ʜ]. IPA also has letters for other epiglottal fricatives.
21. Voiced Epiglottal Fricative: [ʢ]. Both [ʜ] and [ʢ] are treated by IPA as having allophonic trilling, but these might be better analyzed as pharyngeal trills (Esling (2010)).
22. Voiceless Velo-pharyngeal Fricative: [ʩ] – often occurs with a cleft palate.
23. Voiced Velo-pharyngeal Fricative: [ʩ,].

Lateral Fricatives

1. Voiceless Dental Lateral Fricative: [ɬ̪]
2. Voiced Dental Lateral Fricative: [ɮ̪]
3. Voiceless Alveolar Lateral Fricative: [ɬ]
4. Voiced Alveolar Lateral Fricative: [ɮ]
5. Voiceless Postalveolar Lateral Fricative: [ɬ̠] – Mehri
6. Voiceless Retroflex Lateral Fricative: [ꞎ] or extIPA [ꞎ]
7. Voiced Retroflex Lateral Fricative: [ɭ˔] in Ao
8. Voiceless Palatal Lateral Fricative: [ʎ̥˔] or [ʎ̥]
9. Voiced Palatal Lateral Fricative: [ʎ̝] – Allophonic in Jebero
10. Voiceless Velar Lateral Fricative: [ʟ̝̊]
11. Voiced Velar Lateral Fricative: [ʟ̝]
12. Occurrence of Lateral Fricative *ll*: The lateral fricative occurs as the *ll* of Welsh, as in *Lloyd*, *Llewellyn*, and *Machynlleth*, as the unvoiced *hl* and voiced *dl* or *dhl* in the several languages of Southern Africa – such as Xhosa and Zulu, and in Mongolian.
13. Voiceless Grooves Lateral Alveolar Fricative: □ or □͜s or θ͜ɬ - a laterally lisped [s] and [θ] – Modern South Arabian
14. Voiceless Grooves Lateral Alveolar Fricative: □ or □͜z or ð͜□ - a laterally lisped [z] and [ð] – Modern South Arabian

IPA Letters Used for both Fricatives and Approximants

1. Voiced Uvular/Pharyngeal Fricative Symbols: [ʁ] - Voiced Uvular Fricative; [ʕ] – Voiced Laryngeal Fricative.
2. Distinguishing Pharyngeals from Fricatives: No language distinguishes voiced fricatives from approximants at these places, so the same symbol is used for both. For the pharyngeal, approximants are more numerous than fricatives.

3. IPA Symbology for Fricative/Approximant: A fricative realization may be specialized by adding the uptack of the letter [ɰ˔ ʕ˔]. Likewise, downtack may be added to specify an approximate realization [ɰ˕ ʕ˕].
4. Symbols for Bilabial/Dental Approximant: The bilabial approximant and the dental approximant do not have dedicated symbols either and are transcribed in a similar fashion: [β˕ ð˕]. However, the base letters are understood to refer to the fricatives.

Pseudo-Fricatives

1. Voiceless/Breathy-voiced Glottal Transitions: [h] – voiceless glottal transition, as in English *hat*; [ɦ] – breathy-voiced glottal transition.
2. Glottal Fricatives as Phonation States: In many languages, such as English, the glottal *fricatives* are unaccompanied states of the glottis, without any accompanying manner, fricative or otherwise. However, in languages such as Arabic, they are true fricatives (Ladefoged and Maddieson (1996)).
3. Occurrence of Doubly Articulated Fricatives: In addition, [ʍ] is usually called a *voiceless labial-velar fricative*, but is actually an approximant. True doubly articulated fricatives may not occur in any language, but the voiceless palatal-velar fricatives are quoted as a putative – and rather controversial – example.

Aspirated Fricatives

1. How common are Voiced Fricatives? Fricatives are very commonly voiced, though cross-linguistically voiced fricatives are not nearly as common as tenuis – *plain* – fricatives.

2. Phonations in Languages' Stop Consonants: Other phonations are common in languages that have those phonations in their stop consonants. However, phonemically aspirated fricatives are rare.
3. Aspirated Fricatives in Asian Languages: [sʰ] contrasts with [s] in Korean; aspirated fricatives are also found in a few Sino-Tibetan languages, in some Oto-Manguean languages, in Siouan languages Ofo - /sʰ/ and /fʰ/ - and in the Chumash languages /sʰ/ and /ʃʰ/.
4. Aspirated Fricatives in Cone-Tibetan: The record may be Cone-Tibetan, which has four contrastive aspirated fricatives - /sʰ/, /ɕʰ/, /ʂʰ/, and /xʰ/ (Jacques (2011)).

Nasalized Fricatives

1. Examples of Phonemically Nasalized Fricatives: Phonemically nasalized fricatives are rare. Some South Arabian languages have /z̃/, Umbundu has /ṽ/, and Kwangali and Souletin Basque both have /h̃/.
2. Nasality in Coatzospan Mixtec and Igbo: In Coatzospan Mixtec, [β ð s̃ ʃ] appear allophonically before a nasal vowel, and in Igbo nasality is a feature of the syllable; when /f v s z ʃ ʒ/ occur in nasal syllables they are themselves nasalized (Laver (1994)).
3. Types of Fricatives by Passive Articulator: Below is a partial list of fricative types listed by their passive articulators. There are likely to be more aspirated, murmured, and nasal fricatives. PS: <s̚ s̩ sᶺ> are not IPA transcriptions.
4. (Central Non-Sibilant + Lateral Fricative)/ Bilabial: [ɸ β]
5. (Central Non-Sibilant + Lateral Fricative)/ Labiodental: [f v] [fʰ vʰ]
6. Central Non-Sibilant/Linguolabial: [θ̼ ð̼]
7. Central Non-Sibilant/Inter-dental: [θ˔ ð˔] [θ̪̚ ð̪̚]
8. Central Non-Sibilant/Dental: [θ ð]
9. Central Non-Sibilant/Denti-Alveolar: [θ ð - laminal], [ɹ̝̊ ɹ̝ - apical]
10. Central Non-Sibilant/Post-Alveolar: [ɹ̝̊˗ ɹ̝˗]
11. Central Non-Sibilant/(Palatal/Retroflex): [ç ʝ - laminal], [ɻ̝̊ ɻ̝ - apical]

12. Central Non-Sibilant/Velar: [x ɣ̊] [xʰ ɣ̊ʰ]

13. Central Non-Sibilant/Uvular: [χ ʁ̥]

14. Central Non-Sibilant Pharyngeal: [ħ ʕ̝]

15. Central Non-Sibilant Glottal: [h̝ ɦ̝]

16. Lateral Fricative/Dental: [ɬ̪ ɮ̪]

17. Lateral Fricative/Alveolar: [ɬ ɮ] [ɮʰ]

18. Lateral Fricative/Postalveolar: [ɬ̠ ɮ̠]

19. Lateral Fricative/(Palatal/Alveolar): [ʎ̝̊ - laminal] [ɬ (retroflex hook) ɭ˔ - apical]

20. Lateral Fricative/Velar: [ʟ˔]

21. Lateral Sibilant/Dental: [s̪̥ z̪̥]

22. Laminal Sibilant/Denti-Alveolar: [s overbar z overbar] [s̥ z̥]

23. Laminal Sibilant/Alveolar: [s̠ z̠] [s̠ʰ z̠ʰ]

24. Laminal Sibilant/Post-Alveolar: [s̠ z̠] [s̠̻ z̠̻] [ʃ̻ ʒ̻ - domed] [s hat z hat (ʆ □) - closed]

25. Laminal Sibilant (Palatal/Retroflex): [ɕ ʑ] [ɕʰ]

26. Apical Sibilant/Dental: [s̪̺ z̪̺]

27. Apical Sibilant/Alveolar: [s̺ z̺]

28. Apical Sibilant/Post Alveolar: [ṣ ẓ] [s̠̺ z̠̺] [ʃ ʒ] [ʒʰ]

29. Apical Sibilant/(Palatal/Retroflex): [ʂ ʐ] [ʂʰ]

30. Fricative Trill/Alveolar: [r̝̊ r̝]

31. Fricative Trill/Uvular: [ʀ̝̊ ʀ̝]

32. Fricative Trill/Pharyngeal: [ʜ ʢ]

33. Fricative Flap/Alveolar: [ɾ̝̊ ɾ̝]

34. Nasalized Fricative/Bilabial: [β̃]

35. Nasalized Fricative/Labiodental: [f̃ ṽ]

36. Nasalized Fricative/Dental: [ð̃]

37. Nasalized Fricative/Alveolar: [s̃ z̃]

38. Nasalized Fricative/(Postalveolar): [ʃ̃ ʒ̃]

39. Nasalized Fricative/Glottal: [h̃]

Occurrence

1. Language Containing the Most Fricatives: Until its extinction, Ubykh may have been the language with th most fricatives – 29 not including /h/, some of which did not have dedicated symbols or diacritics in the IPA. This number actually outstrips the number of all consonants in English, which has 24 consonants.
2. Languages with No Phonemic Fricatives: By contrast, approximately 8.7% of the world's languages have no phonemic fricatives at all (Maddieson (2008)).
3. Australian Aboriginal and South American Languages: This is a typical feature of Australian Aboriginal languages, where the few fricatives that exist result from changes to plosives or approximants, but also occurs in some indigenous languages from New Guinea and South America that have especially small number of consonants.
4. [h] in Indigenous Australian Languages: However, whereas [h] is entirely unknown in Indigenous Australian languages, most of the other languages without true fricatives do have [h] in their consonant inventory.
5. Voicing Contrasts in Fricatives - Location: Voicing contrasts in fricatives are largely confined to Europe, Africa, and Western Asia.
6. Languages Lacking Voiced Fricative Consonants: Languages of South and East Asia, such as Mandarin Chinese, Korean, Dravidian and Austronesian languages, typically do not have such voiced fricatives as [z] and [v], which are familiar to many European speakers.
7. Voiced Fricatives in Indigenous American: The voiced fricatives are also relatively rare in the Indigenous languages of the Americas.
8. Comparison to Voicing in Plosives: Overall, voicing contrasts in fricatives is much rarer than in plosives, being found in only about a third of the world's languages as compared to 60 percent for plosive voicing contrasts (Maddieson (2005)).
9. Voiced Fricatives without Voiceless Counterpart: About 15 percent of the world's languages, however, have *unpaired voiced fricatives*, i.e., a voiced fricative without a voiceless counterpart. Two-thirds of these, or 10 percent of all languages, have unpaired voiced fricatives but no voicing contrast between any fricative pair (Maddieson and Disner (1984)).

10. Evolution of the Voiced Fricatives: The above phenomenon occurs because voiced fricatives have developed from lenition of plosives or fortition of approximants.
11. Unpaired Voiced Fricatives are non-Sibilant: This phenomenon of unpaired voiced fricatives is scattered throughout the world, but is confined to non-sibilant fricatives with the exception of a couple of languages that have [ʒ] but lack [ʃ]. Relatedly, several languages have the voiced affricate [dʒ] but lack [tʃ], and vice versa.
12. Fricatives without a Voiceless Counterpart: The fricatives that occur most often without a voiceless counterpart are – in the ratio of unpaired occurrences to total occurrences – [j], [β], [ð], [ʁ], and [ɣ].

Acoustics

1. Turbulent Airflow with Period Pattern Overlay: Fricatives appear in waveforms as random noise caused by turbulent airflow, upon which a periodic pattern is overlaid if voiced (Zsiga (2013)).
2. Front-end vs. Back-end Fricatives: Fricatives produced at the front part of the mouth tend to have energy concentration at higher frequencies than ones produced in the back (Johnson (2012)).
3. Center of Airflow Gravity: The center of gravity, the average frequency in the spectrum weighted by the amplitude, may be used to determine the place of articulation of a fricative relative to that of another (Kiss (2013)).

References

- Esling. J. (2010): Phonetic Notation, in: *The Handbook of Phonetic Sciences 2nd Edition Editors: Hardcastle, W. J., J. Laver, and F. E. Gibbon* **Wiley-Blackwell** Hoboken, NJ
- Jacques, G. (2011): A Panchronic Study of Aspirated Fricatives, with New Evidence from Pumi *Lingua* **121 (9)** 1518-1538
- Johnson, K. (2012): *Acoustic and Auditory Phonetics 3rd Edition* **Wiley-Blackwell** Hoboken, NJ
- Kiss, Z. S. (2013): Measuring Acoustic Correlates of Voicing
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Laver, J. (1994): *Principles of Phonetics* **Cambridge University Press** Cambridge, UK
- Lodge, K. (2009): *A Critical Introduction to Phonetics* **Continuum International Publishing Group** New York, NY
- Maddieson, I., and S. F. Disner (1984): *Patterns of Sounds* **Cambridge University** Cambridge, UK
- Maddieson, I. (2005): Voicing in Plosives and Fricatives
- Maddieson, I. (2008): Absence of Common Consonants
- Pountain, C. J. (2017): *Exploring the Spanish Language 2nd Edition* **Routledge** Oxfordshire, UK
- Wikipedia (2021): Fricative
- Zsiga, E. (2013): *The Sounds of Language: An Introduction to Phonetics and Phonology* **Wiley-Blackwell** Hoboken, NJ

Sibilant

Overview

1. Special Characteristics of a Sibilant: Sibilants are fricative consonants of higher amplitude and pitch, made by directing a stream of air with the tongue towards the teeth (Ladefoged and Maddieson (1996), Wikipedia (2021)).
2. Examples and their IPA Symbols: Examples of the sibilants are the consonants at the beginning of the English words *sip*, *zip*, *ship*, and *genre*. The symbols in the International Phonetic Alphabet used to denote the sibilant sounds in these words are, respectively, [s], [z], [ʃ], and [ʒ].
3. Situations of Common Sibilant Usage: Sibilants have a characteristically intense sound, which accounts for their paralinguistic use in getting one's attention, e.g., calling someone using *psst!* or quieting someone using *shhhh!*
4. Characteristics of Alveolar Hissing Sibilants: In the alveolar *hissing* sibilants [s] and [z], the back of the tongue forms a narrow channel, i.e., a is *grooved*, to focus the stream of air more intensely, resulting in a high pitch.
5. Characteristics of Hushing Sibilants/Shibilants: With the hushing sibilants – occasionally termed *shibilants* – such as English [ʃ], [ʧ], [ʒ], and [ʤ], the tongue is flatter, and the resulting pitch is lower.
6. Phones in the Strident Category: A broader category is *stridents*, which include more fricatives such as uvulars in addition to sibilants. Because all sibilants are also stridents, the terms are used interchangeably. However, the terms do not mean the same thing.
7. English IPA Stridents and Sibilants: The English stridents are /f, v, s, z, ʃ, ʒ, ʧ, ʤ /. Sibilants are higher pitched subset of the stridents. The English sibilants are /s, z, ʃ, ʒ, ʧ, ʤ/. /f/ and /v/ are stridents, not sibilants, because they are of lower pitch.

8. Role of Teeth in Sibilants: *Stridency* refers to the perceptual intensity of the sound of a sibilant consonant, or *obstacle fricative* or *affricate*, which refers to the critical role of the teeth in producing the sound as a obstacle to the airstream.
9. Articulation of Non-sibilant Fricatives: Non-sibilant fricatives and affricates produce their characteristic sound directly with tongue or lips etc. and the place of contact in the mouth, without secondary involvement of the teeth.
10. Sensitivity to Tongue Shape/Position: The characteristic intensity of sibilants means that small variations in the tongue shape and position are perceivable, with the result that there are many sibilant types that contrast in various languages.

Acoustics

Sibilants are louder than their non-sibilant counterparts, and most of their acoustic energy occurs at higher frequencies than non-sibilant fricatives – usually 8000 Hz.

Sibilant Types

1. Impact of Tongue on Sibilants: All sibilants are coronal consonants, i.e., sounds are made with the tip or the front part of the tongue. However, there is a great deal of variety among sibilants as to tongue shape, point of contact on the tongue, and point of contact on the upper side of the mouth.
2. Variables Impacting Sibilant Sound Quality: The following variables affect sibilant sound quality, and along with their possible values, are ordered from sharpest/highest pitched to dullest/lowest pitched.
3. Tongue Shape: Grooved, alveolopalatal, palatoalveolar, retroflex.

4. Place of Articulation: This refers to the point of contact on the upper side of the mouth: dental or denti-alveolar, alveolar, postalveolar, palatal.
5. Point of Contact on the Tongue: Laminal *closed* – see below, laminal non-*closed*, apical, subapical.
6. Co-occurrence of the above Variables: Generally, the values of the different variables co-occur so as to produce an overall sharper or duller sound. For example, a laminal denti-alveolar grooved sibilant occurs in Polish, and a subapical palatal retroflex occurs in Toda.

Tongue Shape

1. Tongue Shape as a Premier Distinguisher: The main distinction is the shape of the tongue. Most sibilants have a groove running down the centerline of the tongue that helps focus the airstream, but it is not known how widespread this is.
2. Tongue Shapes Used in Sibilants: In addition, the following tongue shapes are described, from sharpest and highest pitched to dullest and lowest pitched.
3. Hollow, e.g. [s z]: The tongue hollow accepts a large volume of air that is forced through a typically narrow aperture that directs a high-velocity jet of air against the teeth, which results in a high-pitched, piercing *hissing* sound.
4. Prominence of Hollow Tongue Shape: Because of the prominence of these sounds, they are the most common and the most stable of sibilants cross-linguistically. They occur in English, where they are denoted with a letter *s* or *z*, as in *soon* or *zone*.
5. Alveolopalatal, e.g., [ɕ ʑ]: These sounds are produced with a convex, V-shaped tongue, and are highly palatalized, i.e., the middle of the tongue is strongly raised or bowed.
6. Palatoalveolar, e.g., [ʃ ʒ]: This is produced with a *domed* tongue – convex and moderately palatalized. These sounds occur in English and are denoted with the letter combinations *sh*, *ch*, *g*, *j*, or *si*, as in *shin*, *chin*, *gin*, and *vision*.

7. Retroflex, e.g., [ʂ ʐ]: These are produced with a flat or concave tongue, with no palatalization. There is a variety of these sounds, some of which also go by other names, e.g., *flat postalveolar* or *apico-alveolar*.
8. Subapical Palatal/True Retroflex Sounds: The subapical palatal or *true* retroflex sounds are the dullest and lowest pitched of all sibilants.
9. Tongue Shape *Hissing* vs *Hushing*: The latter three postalveolar sounds are often known as *hushing* sounds because of their quality, as opposed to the *hissing* alveolar sounds. The alveolar sounds in fact occur in several varieties, in addition to the normal sound of English *s*.
10. Palatalized: Sibilants can occur with or without raising the tongue body to the palate, i.e., palatalization.
11. Transcribing the Palatalized Alveolar Sounds: Palatalized alveolar sounds are transcribed as, for example, [sʲ], and occur in Russian; they sound similar to the cluster [sj] occurring in the middle of the English phrase *miss you*.
12. Lisping: Alveolar sibilants made with the tip of the tongue, i.e., apical, near the upper teeth have a softer sound reminiscent of – but still sharper-sounding than – the *lisping* [θ] sound of English *think*.
13. Occurrence of Alveolar Lisping Sounds: These sounds are relatively uncommon, but occur in some of the indigenous languages of California (Bright (1978)), as well as in the Spanish dialects of Western and Southern Andalucía, i.e., Southwest Spain, mostly in the provinces of Cadiz, Malaga, Sevilla, and Huelva.
14. Lisping Sibilants in Spanish Symbology: In these dialects, the lisping sibilant [s] – sometimes indicated in Spanish dialectology as <s> - is the most common pronunciation of the letters *s* or *z*, as well as *c* before *i* or *e*, replacing the [s̺] or [θ] that occur elsewhere in the country (Obaid (1973), Dalbor (1980)).
15. Pronouncing Retroflex and Alveolopalatal Consonants: The retroflex consonant [] sounds somewhat like a mix between the regular English [ʂ] of *ship* and a string American *r*; while the alveolopalatal consonant [ʃ] sounds somewhat like a mixture of English [ʃ] of *ship* and the [sj] in the middle of *miss you*.

Place of Articulation

Sibilants can be made at any coronal articulation, i.e., the tongue can contact the upper side of the mouth anywhere from the upper teeth – dental – to the hard palate – palatal, with the in-between articulations being denti-alveolar, alveolar, and postalveolar.

Point of Contact on the Tongue

1. Apical, Laminal, and Subapical Articulations: The tongue can contact the upper side of the mouth with the very tip of the tongue, i.e., and *apical* articulation, e.g., [ʃ̺]; with the surface just behind the tip, called *blade* of the tongue, i.e., a *laminal* articulation, e.g., [ʃ̻]; or with the underside of the tip, a *subapical* articulation.
2. Tongue-up and Tongue-down Articulations: Apical and subapical articulations are always *tongue-up*, with the tip of the tongue above the teeth, while laminal articulations can be tongue-up or *tongue-down*, with the tip of the tongue behind the lower teeth.
3. Three Varieties of Retroflex Sibilants: This distinction is particularly important for retroflex sibilants, because all three varieties can occur, with noticeably different sound qualities.
4. Distinctions in Tongue-Down Laminal: For tongue-down laminal articulations, and additional distinction can be made depending on where exactly behind the lower teeth the tongue tip is placed.
5. Hollow Area Beneath Lower Teeth: A little ways back from the lower teeth is a hollow area – or pit – in the lower surface of the mouth.
6. Sublingual Cavity - Duller/Sharper Sounds: When the tongue tip rests in this hollow area, there is an empty space below the tongue – *sublingual cavity* – which results in a relatively duller sound. When the tip of the tongue rests against the lower teeth, there is no sublingual cavity, resulting in a sharper sound.

7. Tongue Tip Correlates with Tongue Shape: Usually, the position of the tip of the tongue correlates with the grooved vs. hushing tongue shape so as to maximize the differences. However, the palatoalveolar sibilants in the Northwest Caucasian languages such as Ubykh are an exception.
8. Hissing/Hushing/*Closed* laminal Palatoalveolar: These sounds have the tongue tip resting directly against the lower teeth, which gives the sounds a quality that Catford describes as *hissing-hushing*. Ladefoged and Maddieson (1996) term this a "*closed* laminal postalveolar" articulation, and transcribe them – following Catford – as [*s*^ *z*^], although this is not an IPA notation.

Symbols in the IPA

1. IPA Symbols for Sibilants: This section shows the types of sibilant fricatives defined in the International Phonetic Alphabet.
2. Voiceless Alveolar Sibilant:

IPA	Language	IPA	Meaning
s	English	[**s**ɪp]	*sip*

3. Voiceless Alveolopalatal Sibilant:

IPA	Language	IPA	Meaning
ɕ	Mandarin	[**ɕ**jaʊ̯]	*small*

4. Voiceless Retroflex Sibilant:

IPA	Language	IPA	Meaning

ʂ	Mandarin	[**ʂ**âŋ.xàɪ̯]	*Shanghai*

5. Voiced Alveolar Sibilant:

IPA	**Language**	**IPA**	**Meaning**
z	English	[**z**ɪp]	*zip*

6. Voiced Alveolopalatal Sibilant:

IPA	**Language**	**IPA**	**Meaning**
ʑ	Polish	[‘**ʑ**ɔwɔ]	*herb*

7. Voiced Palatoalveolar Sibilant:

IPA	**Language**	**IPA**	**Meaning**
ʒ	English	[‘**v**ɪʒən]	*vision*

8. Voiced Retroflex Sibilant:

IPA	**Language**	**IPA**	**Meaning**
ʐ	Russian	[**ʐ**abə]	*toad*
	Polish	[**ʐ**əbə]	*frog*

9. Additional Phonetic Qualifiers using Diacritics: Diacritics can be used for finer detail. For example, apical and laminal alveolars can be specified as [s̺] vs [s̻]; dental, or more likely *denti-alveolar* sibilant as [s̪]; palatalized alveolar as [sʲ]; and generic *retracted sibilant* as [s̠],

a transcription frequently used for the shaper-quality types of retroflex consonants, e.g., the laminal *flat* type and the *apico-alveolar* type.

Possible Combinations

1. <u>Realizations and their Language Occurrences</u>: The attested possibilities, with their example languages, are shown in this section. Note that the IPA diacritics are simplified; some articulations would require two diacritics to be fully specified, but only one is used in order to keep the results legible with the need for OpenType IPA fonts.
2. <u>The Underdot Apical Postalveolar Notation</u>: Also, Ladefoged has resurrected an obsolete IPA symbol, the underdot, to indicate *apical postalveolar* – normally included in the category of retroflex consonants, and that notation is used here.
3. <u>Switch across s̠, ṣ, and ʂ</u>: Note that the notation s̠, ṣ is sometimes reversed; either may be called *retroflex* and written ʂ.
4. <u>[s̪̺ z̪̺]</u>:

Tongue Shape	Hollow
Place of Articulation (Upper)	Dental
Place of Articulation (Lower)	Apical
Examples	Southeast European Spanish *s/z* Kumeyaay

5. <u>[s̪ z̪]</u>:

Tongue Shape	Hollow
Place of Articulation (Mouth)	Denti-alveolar

Place of Articulation (Tongue)	Laminal
Examples	Polish *s*, *z* Basque *z*, *tz*

6. [s̺ z̺]:

Tongue Shape	Hollow
Place of Articulation (Mouth)	Alveolar
Place of Articulation (Tongue)	Apical
Examples	Northern Peninsular Spanish *s* Basque *s*, *ts* Mandarin *s*, *z*, *c* (apical, dental, or alveolar)

7. [s z]:

Tongue Shape	Hollow
Place of Articulation (Mouth)	Alveolar
Place of Articulation (Tongue)	Apical or Laminal
Examples	English *s*, *z* (alveolar, laminal, or apical) American or Southwest European Spanish *s/z*

8. [s̻ z̻]:

Tongue Shape	Hollow
Place of Articulation (Mouth)	Alveolar

Place of Articulation (Tongue)	Laminal
Examples	Toda Ubykh Abkhaz

9. [ʃ ʒ]:

Tongue Shape	Domed
Place of Articulation (Mouth)	Postalveolar
Place of Articulation (Tongue)	Apical or Laminal
Examples	English *sh*, *ch*, *j*, *zh* French *ch*, *j* ([ʃʷ ʒʷ])

10. [ʃ̻ ʒ̻]:

Tongue Shape	Domed
Place of Articulation (Mouth)	Postalveolar
Place of Articulation (Tongue)	Laminal
Examples	Toda Basque *x*, *tx*

11. [ɕ ʑ]:

Tongue Shape	Palatalized
Place of Articulation (Mouth)	Postalveolar

Place of Articulation (Tongue)	Laminal
Examples	Mandarin *x, j, q* Basque *ś, ć, ź, dź* Ubykh Abkhaz

12. [ŝ ẑ]: This is an ad-hoc transcription. The old IPA uses <ʆ ʓ> instead.

Tongue Shape	Hollow (No cavity)
Place of Articulation (Mouth)	Postalveolar
Place of Articulation (Tongue)	Laminal
Examples	Ubykh Abkhaz

13. [s̠ z̠], [ʂ̻ ʐ̻]:

Tongue Shape	Hollow or Flat (Cavity under Tongue)
Place of Articulation (Mouth)	Postalveolar
Place of Articulation (Tongue)	Laminal
Examples	Polish *sz, cz, ż, dż* (ʂ̻ʷ, tʂ̻ʷ, ʐ̻ʷ, dʐ̻ʷ) Mandarin *sh*, *ch*, *zh*

14. Hollow Postalveolar Apical Note #1: These sounds are usually just transcribed <ʂ ʐ>. Apical postalveolar and subapical sibilants do not contrast in any language, but, if necessary, apical postalveolars can be transcribed with an apical diacritic, as <s̻ z̻> or <ʂ̺ ʐ̺>.

15. Hollow Postalveolar Apical Note #2: Ladefoged resurrects the old retroflex sub-dot for apical retroflexes <ṣ z underdot>. Also seen in the literature on, e.g., Hindi and Norwegian is <ʃ̢ ʒ̢> - the domed articulation of [ʃ ʒ] precludes a subapical realization.

16. [ʂ ʐ], [s̥ z̥], etc.:

Tongue Shape	Hollow
Place of Articulation (Mouth)	Postalveolar
Place of Articulation (Tongue)	Apical
Examples	Ubykh Abkhaz Kumeyaay Toda Russian

17. [ʂ ʐ]:

Tongue Shape	Curled
Place of Articulation (Mouth)	Palatal (or Postalveolar?)
Place of Articulation (Tongue)	Subapical
Examples	Toda

Whistled Sibilants

1. Occurrences of Whistled Sibilant Consonants: Whistled sibilants occur in speech pathology and may be caused by dental prosthesis or orthodontics. However, they may also occur phonemically in several Southern Bantu languages, the best-known being Shona.
2. Extended IPS Shona Whistled Sibilants: The whistled sibilants of Shona have been variously described as labialized but not velarized, as retroflex, etc., but none of these features are required for the sounds (Shosted (2006)). Using the Extended IPA, Shona *sv* and *zv* may be transcribed as <s͎> and <z͎>.
3. Purely Labialized and Labially Coarticulated: Other transcriptions seen include purely labialized <s^w> and <z^w> (Ladefoged and Maddieson (1996)) and labially coarticulated <$s^ɸ$> and <$z^β$> - or <s͡ɸ> and <z͜β>.
4. Shona Sibilant Transcription of Doke: In the otherwise IPA transcription of Shona by Doke (1967), the whistled sibilants are transcribed with the non-IPA letters <ȿ ɀ> and <tȿ dɀ>.
5. Whistled Sibilants in Other Languages: Besides Shona, whistled sibilants have been reported as phonemes in Kalanga, Tsonga, Changana, Tshwa – all of which are Southern African languages – and Tabasaran. The articulation of whistled sibilants may vary between languages.
6. Whistled Sibilant Articulation in Shona: In Shona, the lips are compressed throughout, and the sibilant may be followed by a normal labialization upon release. That is, there is a contrast between *s*, *sw*, *ȿ*, and *ȿw*.
7. Whistled Sibilant Articulation in Tsonga: In Tsonga, the whistling effect is weak; the lips are narrowed but also the tongue is reflex. Tswa may be similar.
8. Whistled Sibilant Articulation in Changana: In Changana, the lips are rounded/protruded, as in /s/ in the sequence /usu/, so there is evidently some distinct phonetic phenomenon occurring here that has yet to be formally identified and descried (Maddieson and Sands (2019)).

Linguistic Contrasts Among Sibilants

1. Number of Sibilants in Languages: Not including manner of articulation or the secondary articulation, some languages have as many as four different types of sibilants.
2. Qiang Languages – 4-way Distinction: For example, Northern Qiang and Southern Qiang have four-way distinction among sibilant affricates /ts/, /tʂ/, /tʃ/, /tɕ/, with one for each of the four tongue shapes.
3. 4-way Sibilants in Toda: Toda also has a 4-way sibilant distinction, with one alveolar, one postalveolar, and two reflexes – apical postalveolar and subapical palatal.
4. 27-way Sibilants in Ubykh: The now extinct Ubykh language was particularly complex, with a total of 27 sibilant consonants. Not only all 4 tongue shapes were represented – with the palatoalveolar appearing in the terminal *closed* variation – but also both the palatoalveolar and the alveolopalatal could additionally appear labialized.
5. Three Missing Labialized Palatoalveolar Affricates: Besides, there was a five-way manner distinction among voiceless and voiced fricatives, voiceless and voiced affricates, and ejective affricates. The three labialized palatoalveolar affricates were missing, which is why the total was 27, not 30.
6. Bzyp Dialect of Abkhaz Language: The Bzyp dialect of the related Abkhaz language also has a similar inventory.
7. Variations of Palatalization among Sibilants: Some languages have 4 types when palatalization is considered. Polish is one example, with both palatalized and non-palatalized laminal denti-alveolars, laminal postalveolar – or *flat retroflex* – and alveolopalatal – [s̻ z̻] [s̻ʲ z̻ʲ] [s̠ z̠] [ɕ ʑ].
8. Palatalization Sibilant Variations among Russian: Russian has the same surface contrasts, but the alveolopalatals are arguably not phonemic. They occur only geminate, and the retroflex consonants never occur geminate, which suggests that both are allophones of the same phoneme.
9. Languages with Hissing/Hushing Sibilants: Somewhat more common are languages with three sibilant types, including one hissing and two hushing.
10. Postalveolar and Alveolopalatal Hushing Sibilants: As with Polish and Russian, the two hushing types are usually postalveolar and alveolopalatal since these are the two most distinct from each other. Mandarin Chinese is an example of such a language; however, other possibilities exist.

11. Sibilants in Southern/Southeastern Europe: Serbo-Croatian has alveolar, postalveolar, and alveolopalatal affricates whereas Basque has palatoalveolar and laminal and apical affricates; late medieval peninsular Spanish and Portuguese had the same distinctions among fricatives.
12. Single Hissing/Hushing Sibilant Languages: Many languages, such as English, have two sibilant types, one hissing and one hushing. A wide variety of languages across the world has this pattern. Perhaps the most common is the pattern, as in English, with alveolar and palatoalveolar sibilants.
13. Modern Spanish Apico-alveolar and Postalveolar Sibilants: Modern northern peninsular Spanish has a single apico-alveolar fricative [s̠], as well as a single palatoalveolar sibilant affricate [tʃ].
14. Instances of Sibilant Retroflexes/Postalveolars: However, there are also languages with alveolar and apical retroflex sibilants, such as Standard Vietnamese, and alveolar and alveolopalatal postalveolars, e.g., alveolar and laminal palatalized [ʃ ʒ tʃ dʒ], i.e., [ʃ ʒ tʃ dʒ] in Catalan and Brazilian Portuguese, the later probably through Amerindian influence, and alveolar and dorsal, i.e., [ɕ ʑ cɕ ɟʑ] proper in Japanese.
15. Languages that Lack Hissing Sibilants: Only a few languages with sibilants lack the hissing type. Middle Vietnamese is normally constructed with sibilant fricatives, both hushing – one retroflex and one alveolopalatal.
16. Single Hushing/No Hissing Sibilants: Some languages have only a single hushing sibilant and no hissing sibilant. That occurs in the Southern Peninsular Spanish dialects of the *ceceo* type, which have replaced the former hissing fricative with [ɵ], leaving only [tʃ].
17. Languages with No Sibilants: Languages with no sibilants are fairly rare. Most have no fricatives at all or only the fricative /h/. Examples include most Australian languages, and Rotokas, and what is generally reconstructed as Proto-Bantu.
18. Languages with No Fricatives but with Sibilants: Languages with fricatives but no sibilants, however, do occur, such as Ukue in Nigeria, which has only the fricatives /f, v, h/.
19. Case of Eastern Polynesian Languages: Furthermore, almost all Eastern Polynesian languages have no sibilants, but do have the fricatives /v/ and/or /f/: Maori, Hawaiian, Tahitian, Rapa Nui, most Cook Island Maori dialects, Marquesan, and Tuamotuan.

20. <u>Sibilants and Fricatives in Tamil</u>: Tamil only has the sibilant /ʂ̩/, and the fricative /f/ in loanwords, and they are frequently replaced by native sounds. The sibilants [s ɕ] exist as allophones of /t͡ɕ/ and the fricative [h] as an allophone of /k/.

Contested Definitions

1. <u>[f] and [v] as Sibilants</u>: Authors including Chomsky and Halle group [f] and [v] as sibilants. However, they do not have the grooved articulation and high frequencies of other sibilants, and most phoneticians (Ladefoged and Maddieson (1996)) continue to group them together with bilabial [ɸ], [β], and inter-dental [ɵ], [ð] as non-sibilant anterior fricatives.
2. <u>Conditions behind Categorization of English [f]</u>: For a grouping of sibilants and [f, v], the term strident is more common. Some researchers judge [f] to be non-strident in English, based on measurements of its comparative amplitude, but to be strident in other languages – for example, in the African language Ewe, where it contrasts with the non-strident [ɸ].
3. <u>Treating Sibilants as Obstacle Fricatives</u>: The nature of *sibilants* as *obstacle fricatives* is complicated – there is a continuum of possibilities relating to the angle at which the jet of air may strike an obstacle.
4. <u>Grooved Presence for Non-sibilants</u>: The grooving often considered necessary for the classification as a *sibilant* has been observed in the ultrasound studies of the tongue for the supposedly *non-sibilant* voiceless alveolar fricative [ɵ] of English (Stone and Lundberg (1996)).

References

- Bright, W. (1978): Sibilants and Naturalness in Aboriginal California *Journal of California Anthropology, Papers in Linguistics* **1** 39-63
- Dalbor, J. B. (1980): Observations on Present Day Seseo and Ceceo in Southern Spain *Hispania, American Association of Teachers of Spanish and Portuguese* **63 (1)** 5-19
- Doke, C. M. (1967): *The Unification of the Shona Dialects* **ALLEX Project** Oslo, Norway
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Maddieson, I., and B. Sands (2019): The Sounds of Bantu Languages, in: *The Bantu Languages (editors: van de Veld, M., K. Bostoen, D. Nurse, and G. Philippson) 2nd Edition* **Routledge** Oxfordshire, UK
- Obaid, A. H. (1973): The Vagaries of Spanish 'S' *Hispania, American Association of Teachers of Spanish and Portuguese* **56 (1)** 60-67
- Shosted, R. K. (2006): Just put your lips together and blow? The whistled fricatives of Southern Bantu
- Stone, M., and A. Lundberg (1996): Three-dimensional Tongue Surface Shapes if English Consonants and Vowels *Journal of the Acoustical Society of America* **99 (6)** 3728-3737
- Wikipedia (2021): Sibilant

Affricate

Overview

1. Affricate from Stop and Fricative: An *affricate* is a consonant that begins as a stop and releases as a fricative, generally in the same place of articulation – most often coronal. It is often difficult to decide if a stop and a fricative form a single phoneme or a consonant pair (Wikipedia (2021)).
2. Examples of Affricates in English: English has two affricate phonemes, /t͡ʃ/ and /d͡ʒ/.

IPA: Affricate Consonants

1. Sibilants: ts, dz | t̠ʃ, d̠ʒ | ʈʂ, ɖʐ | tɕ, dʑ
2. Non-sibilants: p̪f, b̪v | t̠ɹ̝̊, d̠ɹ̝ | cç, ɟʝ | kx, ɡɣ | qχ, ɢʁ | ʡʢ, ʔh
3. Lateral: tɬ, dɮ | ʈɭ̊˔, ɖɭ˔ | cʎ̝, ɟʎ̝̊ | kʟ̝̊, ɡʟ̝
4. Ejective: ts’ | tʃ’ | ʈʂ’ | kx’ | qχ’ | tɬ’ | cʎ̝̊’ | kʟ̝̊’

Examples

1. Common Affricates in World' Languages: The English sounds spelt *ch* and *j* – broadly transcribed as [t͡ʃ] and [d͡ʒ] in the IPA, the German and Italian *z* [t͡s] and the Italian *z* [d͡z] are typical affricates, and sounds like these are fairly common in world's languages, as are other affricates with similar sounds, such as those in Polish and Chinese.
2. Affricates that are Rare/Unattested: However, voiced affricates other than [d͡ʒ] are relatively uncommon. For several other places of articulation, they are not attested at all.
3. Labiodental and Velar Affricates' Occurrence: Much less common are labiodental affricates, such as [p͡f] in German and Izi, or velar affricates such as [k͡x] in Tswana – written *kg* – or in High Alemannic Swiss German accents.
4. Occurrence of the Corresponding Plosives: Worldwide, relatively few languages have affricates in these positions, even though the corresponding stop consonants [p] and [k] are common or virtually universal.
5. Alveolar Affricated with Lateral Release: Also less common are alveolar affricates where the fricative release is lateral, such as the [t͡ɬ] sound found in Nahuatl and Navajo.
6. Affricate Varieties in Athabaskan Languages: Some other Athabaskan languages, such as Dene Suline, have unaspirated, aspirated, and ejective series of affricates whose release may be dental, alveolar, postalveolar, or lateral: [t̪͡θ], [t̪͡θʰ], [t̪͡θ'], [t͡s], [t͡sʰ], [t͡s'], [t͡ʃ], [t͡ʃʰ], [t͡ʃ'], [t͡ɬ], [t͡ɬʰ], [t͡ɬ'].

Notation

1. IPA as a Plosive/Fricative Combination: Affricates are transcribed in the International Phonetic Alphabet by a combination of two letters, one for the stop element, and the other for the fricative element.
2. Use of Upper/Lower Tie Bar: In order to show that these are parts of a single consonant, a tie bar is generally used. The tie bar appears most commonly above the two letters, but may be placed under them if it fits better there, or simply because it is more legible (Niesler, Loew, and Roux (2005)).

3. Affricate Symbols with Tie Bars: Thus: <p͡f, t͡s, d͡z, t͡ɬ, t͡ʃ, d͡ʒ, t͡ɕ, d͡ʑ, ʈ͡ʂ, ɖ͡ʐ, k͡x> OR <p͜f, t͜s, d͜z, t͜ɬ, t͜ʃ, d͜ʒ, t͜ɕ, d͜ʑ, ʈ͜ʂ, ɖ͜ʐ, k͜x>.
4. Fricative Release using a Superscript: A less common notation indicates the release of the affricate with a superscript: <p^{f}, t^{s}, d^{z}, t^{ʃ}, d^{ʒ}, k^{x}>. This is derived form the IPA convention of indicating other releases with a superscript. However, this convention is more typically used for a fricative release that is too brief to be considered a true affricate.
5. Deprecated IPA Symbols - Unicode Ligature: though they are no longer standard IPA, ligatures are available in Unicode for 8 common affricates <ʦ, ʣ, ʧ, ʤ, ʨ, ʥ, ., .>
6. Affricates vs. Stop-Fricative Pairs: Any of these notations can be used to distinguish an affricate from a sequence of stop plus a fricative, which exist in some languages such as Polish. However, in languages where there is no such distinction, such as English, the tie bars are commonly dropped.
7. Symbology in the Americanist System: In other phonetic transcription systems, such as the Americanist system, affricates may be transcribed with a single letter. The affricates [t͡s], [d͡z], [t͡ʃ], [d͡ʒ], [t͡ɬ], [d͡ɮ] are transcribed respectively as <c> or <c cross>; <j>, <z>, or (older) <ʒ>; <c or <č>; <ǰ>, <ǧ>, or (Older) <ǯ>; <λ>; and <ƛ> or <dl>.
8. Occasional Use of Palatal Stops: Within the IPA, [tʃ] and [dʒ] are sometimes transcribed with the symbols for th palatal stops <c> and <ɟ>.

Affricates vs. Stop-Fricative Sequences

1. Contrasting Affricates with Stop-Fricatives: In some languages, affricates contrast with stop-fricative sequences.
2. Example - Polish: Polish affricate /t͡ʂ/ in *czysta* ‘clean (f.)’ versus stop-fricative /t͡ʂ/ in *trzysta* ‘three hundred’ (Gussmann (2007)).
3. Example - Klallam: Klallam affricate /t͡s/ in *k’*^{w}*ə’nc* ‘look at me’ versus stop-fricative in *k’*^{w}*ə’nts* ‘he looks at it’.

4. Lag between Stop and Release Burst: The exact phonetic difference varies between languages. In stop-fricative sequences, the stop has a release burst just before the fricative starts; but in affricates, the fricative element *is* the release.
5. Syllabic Stop-Fricative Sequences: Phonologically, stop-fricative sequences may have a syllable boundary between two segments, but not necessarily.
6. Phonemic Stop-Fricative Sequences in English: In English, /ts/ and /dz/ - *nuts*, *nods* – are considered phonemically stop-fricative sequences. They often contain a morpheme boundary – for example, $nuts = nut + s$ The English affricate phonemes t͡ʃ and d͡ʒ do not generally contain morpheme boundaries.
7. Syllable Boundaries in the Dialect Context: Depending on the dialect, English speakers may distinguish an affricate from a stop-fricative sequence in some contexts such as when the sequence occurs across syllable boundaries.
8. English Stop Fricative Sequence Example: The /t/ in *bent shudder* debuccalizes to a glottal stop before /ʃ/ in many dialects, making it phonemically distinct from /t͡ʃ/.
    a. *bent shudder* /bɛnt.ʃʌdəɹ/ -> bɛntʔʃʌdəɹ
    b. *bench udder* /bɛnt͡ʃ.ʌdəɹ/ -> bɛnt͡ʃʌdəɹ
9. Rise-Time Fricative Amplitude Increase: One acoustic criterion for differentiating affricates from stop-acoustic sequences is the rate of amplitude increase in the frication noise, which is known as the *rise-time*.
10. Affricate/Stop-Fricative Rise Times: Affricates have a short rise time to the peak frication amplitude, stop-fricative sequences have longer rise times (Howell and Rosen (1983), Johnson (2003), Mitani, Kitama, and Sato (2006)).

List of Affricates

1. Plosive Component of Coronal Affricates: In the case of coronals, the symbols <t, d> are normally used for the stop portion of the affricate regardless of the place. For example, [t͡ʂ] is commonly seen for [ʈ͡ʂ].

2. Example Caveats - Further Verification Required: The example languages are the ones that are reported to have these sounds, but in several cases they may need confirmation.

Sibilant Affricates

1. Voiceless Alveolar Affricate t͡s: German, Japanese, K’iche, Mandarin, Italian, Pashto.
2. Voiceless Dental Affricate t̪͡s̪: Hungarian, Macedonian, Serbo-Croatian, Polish.
3. Voiceless Alveolar Affricate t͡ɕ: Mandarin, Polish, Serbo-Croatian, Thai, Vietnamese.
4. Voiceless Palatoalveolar Affricate t͡ʃ: English, French, German, Hungarian, Italian, K’iche, Persian, Spanish.
5. Voiceless Retroflex Affricate ʈ͡ʂ: Mandarin, Polish, Serbo-Croatian, Slovak, Vietnamese.
6. Voiced Alveolar Affricate d͡z: Japanese (some dialects), Italian, Pashto.
7. Voiced Dental Affricate d̪͡z̪: Hungarian, Macedonian, Bulgarian, Polish.
8. Voiced Alveolopalatal Affricate d͡ʒ: Japanese Polish Serbo-Croatian, Korean.
9. Voiced Palatoalveolar Affricate d͡ʑ: Arabic, English, French, Hungarian.
10. Voiced Retroflex Affricate ɖ͡ʐ: Polish, Serbo-Croatian, Slovak.
11. Sibilants of Northwest Caucasian Languages: The Northwest Caucasian languages Abkhaz and Ubykh both contrast sibilant affricates at four places of articulation: alveolar, postalveolar, alveolopalatal, and retroflex. They also distinguish voiceless, voiced, and ejective affricates at each of these.
12. Languages with a Single Affricate: When a language has only one type of affricate, it is usually a sibilant; this is the case in, e.g., Arabic [d̠ʒ], most dialects of Spanish [t̠ʃ], and Thai [tɕ].

Non-sibilant Affricates

1. Voiceless Bilabial Affricate:

IPA	[pɸ]
Languages	Present allophonically in Kaingang and Taos. Not reported as a phoneme in any natural language.

2. Voiceless Bilabial-Labiodental Affricate:

IPA	[pf]
Languages	German, Teke

3. Voiceless Labiodental Affricate:

IPA	[p̪f]
Languages	XiNkuna Tsonga

4. Voiceless Dental Non-Sibilant Affricate:

IPA	[t̪θ]
Languages	New York English, Luo, Dene Suline, Cun, some varieties of Venetian and other North Italian dialects

5. Voiceless Retroflex Non-Sibilant Affricate:

IPA	[tɻ̊]
Languages	Mapudungan, Malagasy

6. Voiceless Palatal Affricate:

IPA	[cç]
Languages	Skolt Sami (younger speakers), Hungarian (casual speech), Albanian (transcribed as [c]), and allophonically in Kaingang

7. Voiceless Velar Affricate:

IPA	[kx]
Languages	Tswana, High Alemannic German

8. Voiceless Uvular Affricate:

IPA	[qχ]
Languages	Nez Perce, Wolof, Bats, Kabardian, Avar, Tsez. Not reported to contrast with a voiceless uvular plosive [q] in natural languages.

9. Voiceless Pharyngeal Affricate:

IPA	[ʡħ]
Languages	Haida. Not reported to contrast with an epiglottal stop [ʡ].

10. Voiceless Glottal Affricate:

IPA	[ʔh]
Languages	Yuxi dialect, English.

11. Voiced Bilabial Affricate:

IPA	[bβ]
Languages	Allophonic in Banjun and Shipibo (Valenzuela, Marquez Pinedo, and Maddieson (2001))

12. Voiced Bilabial-Labiodental Affricate:

IPA	[bv]
Languages	Teke

13. Voiced Labiodental Affricate:

IPA	[b̪v]
Languages	XiNkuna Tsonga

14. Voiced Dental Non-Sibilant Affricate:

IPA	[d̪ð]
Languages	New York English, Dene Suline

15. Voiced Dental Non-Sibilant Affricate:

IPA	[d̪ð]
Languages	New York English, Dene Suline

16. Voiced Retroflex Non-Sibilant Affricate:

IPA	[dɻ̝]

Languages	Malagasy

17. Voiced Palatal Affricate:

IPA	[ɟʝ]
Languages	Skolt Sami (younger speakers), Hungarian (casual speech), Albanian (transcribed [ɟ]), some Spanish dialects. Not reported to contrast with a voiced palatal plosive [ɟ].

18. Voiced Velar Affricate:

IPA	[ɡɣ]
Languages	English

19. Voiced Uvular Affricate:

IPA	[ɢʁ]
Languages	Reported from the Raivavae dialect of Austral (Zamponi (1996)) and Ekagi with a velar lateral allophone [ɡʟ] before front vowels

20. Voiced Pharyngeal Affricate:

IPA	[ʡʢ]
Languages	Not attested in any natural language

21. Voiced Dental Non-Sibilant Affricate:

IPA	[ʔɦ]

Languages	Not attested in any natural language

Lateral Affricates

1. Voiceless Alveolar Lateral Affricate:

IPA	[ʈɬ]
Languages	Cherokee, Nahuatl, Navajo, Tswana, etc.

2. Voiceless Alveolar Lateral Affricate:

IPA	[dɮ]
Languages	Gwich’in, Sandawe. Not reported to ever contrast with a voiced alveolar fricative [ɮ]

3. Voiceless Retroflex Lateral Affricate:

IPA	[ɖɭ̝]
Languages	Apical Postalveolar Phonemic [ɖɭ] in Kamkata-vari and Kamviri.

4. Voiceless Palatal Lateral Affricate:

IPA	[cʎ̝̊]
Languages	As ejective [cʎ̝̊’] in Dahalo; in free variation with [tʎ̝̊] in Hadza.

5. Voiced Palatal Lateral Affricate:

IPA	[ɟʎ̝]
Languages	Allophonic in Sandawe.

6. Voiceless Velar Lateral Affricate:

IPA	[kʟ̝̊]
Languages	As a prevelar in Archi and as an ejective [kʟ̝̊] in Zulu, also exist in the Laghuu language.

7. Voiced Velar Lateral Affricate:

IPA	[ɡʟ̝]
Languages	Laghuu

Trilled Affricates

1. Voiceless Trilled Bilabial Affricate:

IPA	[pʙ̥]
Languages	Not attested in any natural language

2. Voiceless Trilled Alveolar Affricate:

IPA	[tr̥]
Languages	Ngkoth

3. <u>Voiceless Epiglottal Affricate</u>:

IPA	[ʡʜ]
Languages	Not attested in any natural language

4. <u>Voiced Trilled Bilabial Affricate</u>:

IPA	[bʙ]
Languages	Kele and Avava. Only reported in an allophone of [mb] before [o] or [u].

5. <u>Voiced Trilled Alveolar Affricate</u>:

IPA	[dr]
Languages	Nias. Fijian and Avava also have this sound after [n].

6. <u>Voiced Epiglottal Affricate</u>:

IPA	[ʡʢ]
Languages	Hydaburg Haida. Cognate to Southern Haida [ɢ], Masset Haida [ʕ] (Bessell (1993)).

7. <u>Dental Stop + Bilabial Trilled Release</u>: Piraha and Wari' have a dental stop with a bilabial trilled release [t̪ʙ̥].

Heterorganic Affricates

1. Navajo/Chiricahua Apache Alveolar Affricate: Although most affricates are homorganic, Navajo and Chiricahua have a heterorganic alveolo-velar affricate [tx] (Hoijer and Opler (1938), Young and Morgan (1987), Ladefoged and Maddieson (1996), McDonough (2003), McDonough and Wood (2008), Iskarous, McDonough, and Wood (2012)).
2. Wari/Piraha/Blackfoot Heterorganic Affricates: As seen before, Wari' and Piraha have a voiceless dental bilabially trilled affricate [t̪ʙ̥], blackfoot has [ks].
3. Northern Soto and Bantu Languages: Other heterorganic affricates are reported for Northern Sotho (Johnson (2003)) and other Bantu languages such as Phuthi, which has alveolar-labiodental affricates [tf] and [dv], and Sesotho, which bilabial-postalveolar affricates [pʃ] and [bʒ].
4. Djeoromitxi has [ps] and [bz]: Pires (1992)

Phonation, Coarticulation, and Other Variants

1. Coronal and Dorsal Ejective Affricates: The coronal and dorsal places of articulation are attested as ejectives as well: [tɵ', ts', tɬ', tʃ', tɕ', tʂ', cʎ̥˔', kx', kʟ̥˔', qχ'].
2. Voiced Ejective Affricates of Khoisan: Several Khoisan languages such as !Xo'o~ are reported to have voiced ejective affricates, but these are actually pre-voiced: [dts', dtʃ'].
3. Aspirated, Murmured, and Pre-nasalized Affricates: Affricates are also commonly aspirated - [m̩p̪fʰ, tɵʰ, tsʰ, tɬʰ, tʃʰ, tɕʰ, tʂʰ]; murmured – [m̩b̪vʱ, d̠ʒʱ]; prenasalized – [n͜dz, n͜dzʱ, n͜ɖʐ, n͜ɖʐʱ].
4. Additional Specializations of Affricates: Labialized, palatalized, velarized, and pharyngealized affricates are also common. Affricates may also have phonemic length, that is, affected by a chroneme, as in Italian and Karelian.

Phonological Representation

1. Phonological Similarity between Affricates and Stops: In phonology affricates tend to behave similarly to stops, taking part in phonological patterns that fricatives do not. Kehrein (2002) analyzes phonetic affricates as phonological stops.
2. Analysis of Sibilant/Lateral Stops: A sibilant or a lateral – and presumably trilled – stop can be realized phonetically only as an affricate and so might be analyzed phonemically as a sibilant or lateral stop.
3. Distinguishing Stops at Different Places of Articulation: In that analysis, affricates other than sibilants and laterals are a phonetic mechanism for distinguishing stops at similar places of articulation, i.e., like more than one labial, coronal, or dorsal place.
4. Instances Distinguishing Affricates from Plosives: For example, Chipewyan has laminal dental [t̪͡θ] vs. apical alveolar [t]; other languages may contrast velar [k] with palatal [c͡ç] and uvular [q͡χ].
5. Enhancing Phonetic Contrasts Among Consonants: Affricates may be a strategy for increasing the phonetic contrast between aspirated or ejective and tenuis consonants.
6. Affricates/Stops with Identical Traits: According to Kehrein (2002), no language contrasts a non-sibilant, non-lateral affricate with a stop at the same place of articulation and with the same phonation and airstream mechanisms, such as /t̪/ and /t̪θ/ or /k/ and /kx/.
7. Feature Based Phonology - Delayed Release: In feature based phonology, affricates are distinguished from stops by the feature [+ delayed release] (Hayes (2009)).

Affrication

1. Stop/Fricative to Affricate Morphing: Affrication – sometimes called *affricization* – is a sound change by which a consonant, usually a stop or a fricative, changes into an affricate. Following are some examples.

2. Anglo Frisian Palatalization: Proto-Germanic /k/ to Modern English /tʃ/, as in *chin* – cf. German *kinn*.
3. Proto-Semitic to Standard Arabic: Proto-Semitic /g/ to Standard Arabic /d͡ʒ/ in all positions, as /d͡ʒamal/ *camel*, cf. Aramaic gamlāʼ, Amharic gəmäl, and Hebrew gamal.
4. Yod Coalescence: Early Modern English /tj dj/ to /tʃ dʒ/
5. High German Consonant Shift: /p t k/ to /pf ts kx/
6. 16th Century Japanese: [t] to [ts, tɕ] before [wᵝ, i] respectively (Takayama (2015)).
7. Word initially in Udmurt: [r] to [dʒ, dʑ] (Csucs (2005)).

Pre-affrication

1. Occurrence of Fricative-Stop Contour: In rare instances, a fricative-stop contour may occur. This is the case in dialects of Scottish Gaelic that have velar frication [ˣ], whereas other dialects have pre-aspiration.
2. Example - Harris Dialect: For example, in the Harris dialect, there is [ʃaˣkʰ] *seven* and [əhʷɔˣkʰ] *eight*, or [ʃax͜kʰ], [əhʷɔx͜kʰ] (Laver (1994)).

References

- Bessell, N. J. (1993): Preliminary Notes on some Pacific Northwest Coast Pharyngeals
- Csucs, S. (2005): *Die Rekonstruktion der Permischen Grundsprache (Bibliotheca Uralica)* **Akademiai Kiado** Budapest, Hungary
- Gussmann, E. (2007): *The Phonology of Polish* **Oxford University Press** Oxford, UK
- Hayes, B. (2009): *Introductory Phonology* **Wiley Blackwell** Hoboken, NJ

- Hoijer, H, and M. E. Opler (1938): *Chiricahua and Mescalero Apache Texts* **University of Chicago** Chicago, IL
- Howell, P., and S. Rosen (1983): Production and Perception of Rise Time in the Voiceless Affricate/Fricative Distinction *Journal of the Acoustical Society of America* **73 (3)** 976-984
- Iskarous, K., J. McDonough, and D. Whelan (2012): A Gestural Account of the Velar Fricative in Navajo *Journal of Laboratory Phonology* **3 (1)** 195-210
- Johnson, K. (2003): *Acoustic and Auditory Phonetics 2nd Edition* **Blackwell Publishing** Malden, MA
- Kehrein, W. (2000): *Phonological Representation and Phonetic Parsing* **De Gruyter** Berlin, Germany
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Laver, J. (1994): *Principles of Phonetics* **Cambridge University Press** Cambridge, UK
- McDonough, J. (2003): *The Navajo Sound System* **Wolters Kluwer** Alphen aan den Rijn, Netherlands
- McDonough, J., and V. Wood (2008): The Stop Contrasts of the Athabaskan Languages **36 (3)** 427-449
- Mitani, S., T. Kitama, and Y. Sato (2006): Voiceless Affricate/Fricative Distinction by Frication during Amplitude Rise and Slope *Journal of the Acoustical Society of America* **120 (3)** 1600-1607
- Niesler, T., P. Rouw, and J. Roux (2005): Phonetic Analysis of Afrikaans, English, Xhosa, and Zulu using South African Speech Databases *South African Linguistics and Applied Language Studies* **23 (4)** 459-474
- Pires, N. N. (1992): Estudo da Gramática da Língua Jeoromitxi (Jabuti)
- Strand, R. F. (2010): Nuristani Languages
- Takayama, T. (2015): Historical Phonology, in: *Handbook of Japanese Phonetics and Phonology (editor: H. Kubozono)* **De Gruyter** Berlin, Germany
- Valenzuela, P. M., L. Marquez Pineda, and I. Maddieson (2001): Shipibo *Journal of the International Phonetic Association* **31 (2)** 281-285
- Wikipedia (2021): Affricate

- Young, R., and W. Morgan (1987): *The Navajo Language* **University of New Mexico** Albuquerque, NM
- Zamponi, R. (1996): Multiple Sources of Glottal Stop in Raivavaean *Oceanic Linguistics* **35 (1)** 6-20

Liquid Consonant

Overview

Liquids are a class of consonants consisting of voiced lateral approximants like /l/ together with rhotics like /r/ (Ladefoged and Maddieson (1996), Gussenhoven and Jacobs (2017), Wikipedia (2021)).

Phonological Properties

Liquids as a class often behave in a similar way in the phonotactics of a language; for example, they often have the greatest freedom in occurring in consonant cluster (Ladefoged and Maddieson (1996)).

Phonological Properties - Metathesis

Liquids are consonants most prone to metathesis:

a) Latin *c**r**ocodilus* – Spanish *cocod**r**ilo* “crocodile”
b) Latin *mi**r**acu**l**um* – Spanish *mi**l**ag**r**o* “miracle”
c) Latin *pe**r**icu**l**um* – Spanish *pe**l**ig**r**o* “danger”
d) Latin *pa**r**abo**l**a* – Spanish *pa**l**ab**r**a* “speech”

Phonological Properties - Dissimilation

Liquids are also prone to dissimilation when they occur in sequence.

Phonological Properties – Dissimilation Sequence r…r > l…r

Latin *pe**r**eg**r**inus* to Old French *pe**l**eg**r**in* (> pilgrim)

Phonological Properties – Dissimilation Sequence r…r > l…r

1. <u>Italian *co**l**one**ll**o* to Middle French *co**r**onne**l***</u>: This instance of a relatively old case of phonetic dissimilation has been artificially undone in the spelling of English *colonel*, whose standard pronunciation is /'kɝ:nəl/ - with the *r* sound – in North American English, or /'kɜ:nəl/ in RP.
2. <u>Former English Spelling - *Coronel*</u>: This was formerly spelt *coronel* and is a borrowing from Middle French *coronnel*.

Nucleus Slot

1. Nucleus Slot – Location Occupied by Vowels: Liquids are also the consonants most prone to occupying the nucleus slot in a syllable, i.e., the slot usually assigned to vowels (Anderson (2018)).
2. Liquids as Center of Syllables: Thus, Czech and other Slavic languages allow their liquid consonants /l/ and /r/ to be the center of their syllables – as witnessed by the classic tongue twister *st**r**č p**r**st sk**r**z k**r**k* “push your finger through your throat”.

Areal Distribution

1. Language Variations among Liquid Consonants: Languages differ in the number and nature of their liquid consonants.
2. Liquid Rhotic and Lateral Allophones: Many languages, such as Japanese, Korean, or Polynesian – see below – have a single liquid phoneme that has both lateral and rhotic allophones (Ladefoged and Maddieson (1996)).
3. English - Lateral and Rhotic Phonemes: English has two liquid phonemes, one lateral, /l/, and one rhotic, /ɹ/, exemplified in the words ***l**ed* and ***r**ed*.
4. European Languages - Lateral/Rhotic Phonemes: Many other European languages have one lateral and one rhotic phoneme.
5. Languages with more than 2 Phonemes: Some, such as Greek, Italian, and Serbo-Croatian, have more than two liquid phonemes. All three languages have the set /l/, /ʎ/, /r/, with two laterals and one rhotic.
6. Languages Contrasting Four Liquid Phonemes: Similarly, the Iberian languages contrast four liquid phonemes: /l/, /ʎ/, /ɾ/, and a fourth phoneme that is an alveolar trill in all but some varieties of Portuguese, where it is a uvular trill or fricative. Also, the majority of Spanish speakers lack /ʎ/ and use the central /j/ instead.
7. Palatalized/Unpalatalized Lateral-Rhotic Pair: Some European languages, for example Russian and Irish, contrast a palatalized lateral-rhotic pair with an unpalatalized or a velarized set, e.g., /l^h/, /r^h/, /l/, /r/ in Russian.

8. North American and Australian Languages: Elsewhere in the world, two liquids of types mentioned above remain the most common attribute of a language's consonant inventory except in North America and Australia.
9. North American Languages without Rhotics: In North America, a majority of languages do not have rhotics at all and there is a wide variety of lateral sounds though most are obstruent laterals rather than liquids.
10. Australian Languages Rich in Liquids: Most Australian languages are very rich in liquids, with some having as many as seven distinct liquids. They typically include dental, alveolar, retroflex, and palatal laterals, and as many as three rhotics.
11. Other Languages with No Rhotics: On the other side, there are many indigenous languages in the Amazon Basin and Eastern North America, as well as a few in Asia and Africa, with no liquids.
12. Polynesian Languages with Single Liquid: Polynesian languages typically have only one liquid, which may be either a lateral or rhotic.
13. Liquids in Polynesian Oceanic Languages: Polynesian Oceanic languages usually have both /l/ and /r/, occasionally more, e.g., Araki has /l/, /ɾ/, /r/, or less, e.g., Mwotlap has only /l/. Hiw is unusual in having a pre-stopped velar lateral /^{g}ʟ/ as its only liquid (Francois (2010)).

References

- Anderson, C. (2018): *Essentials of Linguistics* **McMaster University** Hamilton, ON
- Francois, A. (2010): Phonotactics and Pre-stopped Velar Lateral of Hiw: Resolving the Ambiguity of a Complex Segment *Phonology* **27 (3)** 393-434
- Gussenhoven, C., and H. Jacobs (2017): *Understanding Phonology 4th Edition* **Rutledge** New York, NY
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Wikipedia (2021): Liquid Consonant

Rhotic Consonant

Overview

1. Definition of a Rhotic Consonant: *Rhotic consonants*, or *R-like* sounds, are liquid consonants that are traditionally represented orthographically by symbols derived from the Greek letter ρ, including <R>, <r> in the Latin script, and <Р>, <р> in the Cyrillic script.
2. Upper/Lower Case Roman <R>: They are transcribed in the International Phonetic Alphabet by upper- or lower-case variants of Roman <R>, <r> (Ladefoged and Maddieson (1996)): r, ɾ, ɹ, ɻ, ʀ, ʁ, ɽ, and ɭ.
3. Characteristics common across Rhotic Consonants: This class of sounds is difficult to characterize phonetically; from a phonetic standpoint, there is no single articulatory correlate – manner or place – common to rhotic consonants (Lindau (1978)). Rhotics have instead been found to carry out similar phonological functions or to have similar phonological features across different languages (Wiese (2001)).
4. Example of Peculiarity - Lowered 3rd Formant: Although some have been found to share certain acoustic peculiarities, such as a lowered 3rd formant, further study has revealed that this does not hold true across different languages. For example, the acoustic quality of lowered 3rd formants pertains almost exclusively to varieties of American English.
5. Phonological instead of Phonetic Class: Being *R-like* is an elusive and ambiguous concept phonetically, and the same sounds that function as rhotics in some systems may pattern with fricatives, semi-vowels, or even stops in others – for example, the alveolar tap is a rhotic consonant in many languages; but in North American English, it is an allophone of the stop phoneme /t/, as in *water* (Lindau (1978)). It is likely that rhotics, then, are not a phonetically natural class, but a phonological one instead (Chabot (2019)).

6. Distinction between Rhotic/Non-rhotic Varieties: Some languages have *rhotic* and *non-rhotic* varieties, which differ in the incidence of rhotic consonants. In non-rhotic accents of English, /r/ is not pronounced unless it is followed directly by a vowel.

Types

1. Typical Occurrences of Rhotic Sounds: The most rhotic sounds found in the world’s languages are the following (Ladefoged and Maddieson (1996)).
2. *Trill* - Popularly Known as *Rolled r*: Here, the airstream is interrupted several times as one of the organs of speech – usually the tip of the tongue – vibrates, closing and opening the air passage.
3. Apical Alveolar Trill: If a trill is made with the tip of the tongue against the upper gum, it is called an *apical* – or tongue-tip – *alveolar trill*; the IPA symbol for their sound is [r].
4. Rhoticity of Non-alveolar Trills: Most non-alveolar trills, such as the bilabial one, however, are considered rhotic.
5. Languages that use Trilled Rhotics: Many languages, such as Bulgarian, Swedish, Norwegian, Frisian, Italian, Spanish, Russian, Polish, Ukrainian, Dutch, and most Occitan variants, use trilled rhotics. In the English-speaking world, the stereotyped Scottish rolled [r] is well-known.
6. Alveolar Trill in German Stage Pronunciation: The *stage pronunciation* of German specifies the alveolar trill for clarity.
7. Other Types - Fricative/Voiceless Trills: Rare kinds of trills include Czech <ř> [r̝] – *fricative trill* – and Welsh <rh> [r̥] – *voiceless trill*.
8. ***Tap or Flap***: Tap and flap describe very similar articulations. They are similar to a trill, but involve just one brief interruption of airflow. In many languages taps are used as reduced variants of trills, especially in fast speech.
9. Contrast between Taps and Trills: However, in Spanish, for example, taps and trills contrast, as in *pero* /’peɾo/ - *but* – versus *perro* /’pero/ - *dog*.

10. <u>Flaps used as Basic Rhotics</u>: Also, flaps are used as basic rhotics in Japanese and Korean languages.
11. <u>Flaps as Intervocalic Apical Stops</u>: In Australian English and most dialects of American English, flaps do not function as rhotics but are realizations of intervocalic apical stops - /t/ and /d/, as in *rider* and *butter*. The IPA symbol for this sound is [ɾ].
12. <u>*Alveolar* or *Retroflex Approximant*</u>: This is used in most accents of English, with minute differences. The front part of the tongue approaches the upper gum, or the tongue-tip is curled back towards the roof of the mouth, i.e., *retroflexion*. No or little friction can be heard, and there is no momentary closure of the vocal tract.
13. <u>Symbols for Alveolar/Retroflex Approximants</u>: The IPA symbol for alveolar approximant is [ɹ] and the symbol for the retroflex approximant is [ɻ].
14. <u>Unrounded vs. Rounded Retroflex Approximants</u>: There is a distinction between *unrounded retroflex approximant* and a *rounded* variety that probably dates back to the Anglo-Saxon period and even to this day in some dialects of English, where the orthographic key is *r* for the unrounded version and usually *wr* for the rounded version – these dialects make a differentiation between *right* and *write*.
15. <u>Use of Approximants as Rhotics</u>: These approximants are also used as rhotics in some dialects of Armenian, Dutch, German, and Brazilian Portuguese, depending on phonotactics.
16. <u>*Uvular* - Popularly called *Guttural r*</u>: The back of the tongue approaches the soft palate or the uvula.
17. <u>Uvular R in European Languages</u>: The standard R in European Portuguese, French, German, Danish, and modern Hebrew (Zuckermann (2003)) are variants of this rhotic.
18. <u>Voiced/Voiceless Uvular Fricatives and Trills</u>: If fricative, the sound is often impressionistically described as harsh or grating. This includes voiced uvular fricative, voiceless uvular fricative, and uvular trill.
19. <u>*Burr* Accent of Northern England</u>: In northern England, there were accents that once employed a uvular R, which was called a *burr*.
20. <u>Developmental Non-rhotic Rs</u>: Many non-rhotic British speakers have a labialization to [ʋ] of their R, which is a combination of idiosyncratic and dialectal – Southern and Southwestern England – and, since it includes some RP speakers, is regarded somewhat prestigious.

21. Brazilian Portuguese Dialects #1: Apart from English, in all Brazilian Portuguese dialects, the <rr> phoneme, or /ʁ/, may be realized as other, traditionally non-rhotic fricatives (Barbosa and Albano (2004)) – and most often is so – unless it occurs single between vowels, being so realized as a dental, alveolar, post-alveolar, or retroflex flap.
22. Brazilian Portuguese Dialects #2: In the syllable code, it varies individually as a fricative, a flap, or an approximant, though fricatives are ubiquitous in the Northern and the Northeastern regions and the states of Southeastern Brazil excluding Sao Paolo and surrounding areas.
23. /ʁ/ Inventory in Brazilian Portuguese: The total inventory of /ʁ/ allophones is rather long, or up to [r ɻ̊˔ ç x ɣ χ ʁ ʀ ħ h ɦ], the latter eight being particularly common, while none of them except the archaic [r], that contrasts with the flap in all positions, may occur alone in a given dialect.
24. Voicing in Brazilian Portuguese Dialects: Few dialects, such as *Sulista* and *Fluminense*, give preference to voiced allophones; elsewhere, they are common only as coda, before voiced consonants.
25. Usage as Velar/Glottal Fricative: Additionally, some other languages and variants, such as Haitian Creole and Timorese Portuguese, use velar and glottal fricatives instead of traditional rhotics, too.
26. Rhotics Realization in Vietnamese Dialects: In Vietnamese, depending on the dialect, the rhotic can occur as [z], [ʐ], or [ɹ].
27. Realization in Modern Mandarin Chinese: In modern Mandarin Chinese, the phoneme /ɻ~ʐ/, which is represented as <r> in Hanyu Pinyin, resembles rhotics in other languages, and thus can be considered as rhotic consonant.

Characteristics

1. IPA Representation of Rhotics: In broad transcription, rhotics are usually symbolized as /r/ unless there are two or more types of rhotics in the same language; for example, most

Australian Aboriginal languages, which contrast approximant [ɻ] and trill [r], use symbols *r* and *rr* respectively.

2. IPA Specification for Phonetic Precision: The IOA has a full set of different symbols which can be used whenever more phonetic precision is required: an *r* rotated 180 degrees [ɹ] for alveolar approximant, a small capital R [ʀ] for uvular trill, and a flipped small capital R [ʁ] for the voiced uvular fricative or approximant.
3. Investigating the Commonality among Rhotics: The fact that the sounds conventionally classified as *rhotics* vary greatly in both place and manner in terms of articulation, and also in their acoustic characteristics, has led several linguists to investigate what, if anything, they have in common that justifies grouping them together (Chabot (2019)).
4. Overlap of Properties among Rhotics: One suggestion that has been made is that each member of the class of rhotics shares certain properties with other members of the class, but not necessarily the same properties with all; in this case, rhotics have a "family resemblance" with each other rather than a strict set of shared properties (Lindau (1978)).
5. Rhotics Place in the Sonority Hierarchy: Another suggestion is that rhotics are defined by their behavior on the sonority hierarchy, namely, that a rhotic is any sound that patterns as being more sonorous than a lateral consonant but less sonorous than a vowel (Wiese (2001)).
6. Rhotics Variation Treatment in Sociolinguistics: The potential for variation within the class of rhotics makes them a popular area for research in sociolinguistics (Scobbie (2006)).

Variable Rhoticity – English

English has rhotic and non-rhotic accents. Rhotic speakers pronounce an /r/ in all instances, while non-rhotic speakers only pronounce /r/ at the beginning of a syllable.

Variable Rhoticity – Other Germanic Languages

1. Dropping/Vocalization of Rhotic Consonants: The rhotic consonant is dropped or vocalized under similar conditions in other Germanic languages, notably German, Danish, Dutch from the eastern Netherlands – because of Low German influence – and southern Sweden, possibly because of its Danish history.
2. Syllable Coda Vowel or Semi-vowel: In most varieties of German, with the notable exception of Swiss Standard German, /r/ in the syllable coda is frequently realized as a vowel or a semi-vowel, [ɐ] or [ɐ̯].
3. Rhotic Mapping in Standard Pronunciation: In the traditional standard pronunciation, this happens only in the unstressed ending *-er* and after long vowels: foe example, *besser* [ˈbɛsɐ], *sehr* [zeːɐ̯].
4. Rhotic Mapping Colloquial Speech: In common speech, the vocalization is common after short vowels as well, and additional contractions may occur: for example, *Dorn* [dɔɐ̯n] ~ [dɔːn], *hart* [haɐ̯t] ~ [haːt].
5. Rhotic Mapping in Danish Language: Similarly, Danish /r/ after a vowel is, unless followed by a stressed vowel, either pronounced [ɐ̯], e.g., *mor* "mother" [moɐ̯], *næring* "nourishment" [ˈnɛɐ̯eŋ̩], or merged with the preceding vowel while usually influencing its vowel quality. For instance, /a(ː)r and /ɔːr/ or /ɔr/ are realized as long vowels [aː] and [ɒː], and /ər/, /rə/, and /rər/ are all pronounced [], e.g., *løber* "runner" [ˈlf8ːb̥ɐ], *Søren Kierkegaard* – personal name – [ˌsœːɐn ˈkʰiɐ̯g̊əˌg̊ɒːˀ].

Variable Rhoticity – Astur Leonese

1. Word-final /r/ in Infinitives: In Asturian, word final /r/ is always lost in infinitives if they are followed by an enclitic pronoun, and this is reflected in writing.
2. Examples: Infinitive/Accusative /r/ Dropping: For example, the infinitive form *dar* [dar] plus the 3rd plural dative pronoun "-yos" *da-yos* [da'ʝos], "give to them", of the accusative form "los" *dalos* [da'los], "give them".

3. Dropping of /r/ and Vowel: This occurs even in Southern dialects where the infinitive form will be "dare" [da're], and both the /r/ and the vowel will drop – da-yos, not *dáre-yos.
4. /r/ Dropping before Lateral Consonants: However, most of the speakers also drop the rhotics in the infinitive before a lateral consonant of a different word, and this doesn't show in the writing, e.g., *dar los dos* [da: los ðos], i.e., "give two [things]".
5. /r/ in the Middle of Words: This doesn't occur in the middle of words, e.g., the name *Ca**r**los* [kar'los].

Variable Rhoticity – Catalan

1. Dropping /r/ in Coda Position: In some Catalan dialects, the word-final /r/ is lost in coda position not only in suffixes on nouns and adjectives denoting the masculine singular and plural – written as *-r, -rs,* but also in the "*-ar, -er, -ir*" suffixes of infinitives, e.g., *forner* [fur'ne] "male baker", *forners* [fur'nes], *fer* ['fe] "to do", *lluir* [ʎu'i] "to shine, to look good".
2. Cases where Rhotics are "Recovered": However, rhotics are "recovered" when followed by the feminine suffix *-a* [ə], and when infinitives have single or multiple enclitic pronouns. Notice that two rhotics are neutralized in the coda, with a tap [ɾ] occurring between vowels, and a trill [r] elsewhere; e.g., *fornera* [fur'neɾə] "female baker", *fer-lo* ['ferlu] "to do it – (masculine)", *fer-ho* ['fe27eu] "to do it/that/so", *lluir-se* [ʎu'ir.sə] "to excel, show off".

Variable Rhoticity – French

Final R is generally not pronounced in words ending in *-er*. The R in *parce que,* i.e., because, is not pronounced in informal speech.

Variable Rhoticity – Indonesian and Malaysian Malay

In Indonesian, which is a form of Malay, the final /r/ is pronounced, it has varying forms of Malay spoken on the Malay peninsula. In Indonesia, it is usually a tap version, but for some Malaysian dialects, it is a retroflex r.

Variable Rhoticity – Khmer

Historical final /r/ has been lost in all Khmer dialects except Northern.

Variable Rhoticity – Portuguese

1. <u>/r/ Getting Aspirated or Unpronounced</u>: In some dialects of Brazilian Portuguese, /r/ is unpronounced or aspirated. This occurs most frequently with verbs in the infinitive, which is always indicated by a word-final /r/.
2. <u>/r/ Getting Dropped before Consonant</u>: In some states, however, it happens mostly with any /r/ when preceding a consonant. The “Carioca” accent from the city of Rio de Janeiro is notable for this.

Variable Rhoticity – Spanish

1. <u>/r/ Dropping among Infinitives</u>: Among the Spanish dialects, Andalusian Spanish, Caribbean Spanish (which is descended from and still very similar to Andalusian and Canarian Spanish), Castuo (the Spanish dialect of Extremadura), Northern Colombian Spanish (in cities like Cartagena, Monterias, San Andres, and Sana Marta, but not from Barranquilla, which is mostly rhotic), and the Argentinian dialect spoken in the Tucuman province may have an unpronounced word-final /r/, especially in infinitives, which mirrors the situation in some dialects of Brazilian Portuguese.
2. <u>Free /r/ Variation in Antillean Caribbean</u>: However, in Antillean Caribbean forms, word-final /r/ in infinitives and non-infinitives is often in free variation with word-final /l/ and may relax to the point of being articulated as /i/.

Variable Rhoticity – Thai

The native Thai rhotic is the alveolar trill. The English approximants /ɹ/ and /l/ are used interchangeably in Thai. That is, Thai speakers generally replace an English-derived R with a L, and when they hear L they may write R (Kanokpermpoon (2007)).

Variable Rhoticity – Turkish

1. <u>/r/ Pronunciation in Istanbul Turkish</u>: In Istanbul Turkish, /r/ is always pronounced, with the exceptions in colloquial speech the present continuous tense suffix *yor* as in *gidiyor* – ‘going’, or *yaziyordum* – ‘I was writing, and *bir* – ‘one’ when used as an adjective/quantifier, but not other numbers containing this word, such as *on bir* – ‘eleven’. In these cases, the preceding vowel is not lengthened.

2. <u>Minimal Pairs Preventing /r/ Drop</u>: The unfavorability of dropping /r/ can be explained with minimal pairs, such as *çaldi* – stole – versus *çaldir* – imperative ‘ring’.
3. <u>/r/ Pronunciations in Other Regions</u>: In some parts, of Turkey, e.g., Kastamonu, the syllable-final /r/ is never pronounced, e.g., “gidiya” instead of “gidiyor” – meaning “she/he is going”, “gide” instead of “gider” – meaning “he/she goes”. In “gide”, the preceding vowel e is lengthened and pronounced somewhat between an e and an a.

Variable Rhoticity – Uyghur

1. <u>General Treatment of /r/</u>: Among the Turkic languages, Uyghur displays more or less the same feature, as syllable-final /r/ is dropped, while the preceding vowel is lengthened: for example, *Uyghurlar* [ʔʊɪ’ʁ:1a:] ‘Uyghurs’.
2. <u>Incorrect Use of /r/</u>: The /r/ may, however, sometimes be pronounced in unusually “careful” or “pedantic” speech; in such cases, it is often mistakenly inserted after long vowels even if there is not phonemic /r/ there.

Variable Rhoticity – Yaqui

Similarly in Yaqui, an indigenous language of Northern Mexico, intervocalic or syllable-final /r/ is often dropped with lengthening of the previous vowel: *pariseo* becomes [pa’:seo], *sewaro* becomes [sewajo].

Variable Rhoticity – Lacid

Lacid, whose exonyms in various literature include Lashi, Lachik, Lechi, and Leqi, is a Tibeto-Burman language spoken by the Lacid people. Robert Naftz (Wikipedia (2022)) reports finding an example of rhotic alveolar fricative in Lacid. It is postulated that the segment is a remnant of the rhotic fricative in Proto-Tibeto-Burman.

Variable Rhoticity – Kurdish

1. <u>Shekaki Accent of the Kurmanji Dialect</u>: The Shekaki accent of the Kurmanji dialect of Kurdish is non-rhotic, that is the post-vocalic flap *r* is not pronounced by the trill *R* is.
2. <u>Compensatory Lengthening of the Preceding Vowels</u>: When *r* is omitted, a "compensatory lengthening" of the preceding vowel takes place. For example:
    a. *Sar* – "cold" – pronounced /sa:/
    b. *Torr* – "net" – is pronounced /tor/ with a trilled *r*.
3. <u>Morphological instead of Phonological Syllables</u>: Shekaki retains morphological syllables instead of phonological syllables in non-rhotic pronunciation.

References

- Barbosa, P. A., and E. C. Albano (2004): Brazilian Portuguese *Journal of the International Phonetic Association* **34 (2)** 227-232
- Chabot, A. (2019): What's Wrong with Being a Rhotic *Glossa: A Journal of General Linguistics* **4 (1)** 1-24

- Kanokpermpoon, M. (2007): Thai and English Consonantal Sounds: A Problem or a Potential for ETF Learning? *ABAC Journal* **27 (1)** 57-66
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Lindau, M. (1978): Vowel Features *Language* **54 (3)** 541-563
- Scobbie, J. (2006): (R) as a Variable, in: *Encyclopedia of Languages and Linguistics 2nd Edition (Editor: R. Brown)* **Elsevier** Oxford, UK
- Wiese, R. (2001): The Phonology of /r/, in: *Distinctive Feature Theory (Editors: T. A. Hall)* **Mouton de Gruyter** Berlin, Germany
- Wikipedia (2021): Rhotic Consonant
- Wikipedia (2022): Lashi Language
- Zuckermann, G. (2003): *Language Contact and Lexical Enrichment in Israeli Hebrew* **Palgrave McMillan** London, UK

Approximant

Overview

1. Definition of the Term Approximant: Approximants are speech sounds that involve the articulators approaching each other but not narrowly enough (Ladefoged (1975)) nor with enough articulatory precision (Martinez-Celdran (2004)) to create turbulent airflow.
2. Falls between Fricatives and Vowels: Therefore, approximants fall between fricatives, which do produce a turbulent airstream, and vowels, which produce no turbulence (Martinez-Celdran (2004), Wikipedia (2021)).
3. Class of Sounds Constituting Approximants: This class is composed of sounds like [ɹ] as in *rest*, and semivowels like [j] and [w] – as in *yes* and *west*, respectively, as well as lateral approximants like [l] – as in *less* (Martinez-Celdran (2004)).

Terminology

1. Alternate Terms for Approximants: Before the term was coined, the terms *frictionless continuant* and *semivowel* were used to refer to non-lateral approximants (Ladefoged (1964), Martinez-Celdran (2004)).
2. Excluded Entities among the Sonorants: In phonology, *approximant* is also a distinctive feature that encompasses all sonorants except nasals, including vowels, taps, and trills (Hall (2007)).

Semivowels

1. <u>Articulatory Similarity to Semivowels/Glides</u>: Some approximants resemble vowels in acoustic and articulatory properties and the term *semivowel* and *glide* are often used for these non-syllabic vowel-like segments.
2. <u>Connection between Vowels and Semivowels</u>: The correlation between semivowels and vowels is strong enough that cross-language differences between semivowels correspond with the differences between their related vowels (Maddieson and Emmorey (1985), Ladefoged and Maddieson (1996)).
3. <u>Alternations between Vowels an Semivowels</u>: Vowels and their corresponding semivowels alternate in many languages depending on the phonological environment, or for grammatical reasons, as is the case with the Indo-European ablaut.
4. <u>Semivowels Preceding the corresponding Vowels</u>: Similarly, languages often avoid configurations where a semivowel precedes its corresponding vowel (Kawasaki (1982), Rubach (2002)).
5. <u>Syllable Locations of Semivowels/Approximants</u>: A number of phoneticians distinguish semivowels and approximants by their location in a syllable.
6. <u>Syllable Coda vs Nucleus Position</u>: Although he uses the term interchangeably, Montreuil (2004) remarks that, for example, the final glides of English *par* and *buy* differ from the French *par* – ‘through’ – and *baille* – ‘tub’ in that, in the latter pair, the approximants appear in the syllable coda, whereas, in the former, they appear in the syllable nucleus.
7. <u>Location Constraints in Italian/Spanish</u>: This means that opaque, if not minimal, contrasts can occur in languages like Italian – with i-like sound of *piede* ‘foot’, appearing in the nucleus [‘pi̯ɛ’de], and that of *piano* ‘slow’ appearing in the syllable onset [‘pja’no] (Montreuil (2004)); and Spanish with a near-minimal pair *abyecto* [aβ’jekto] ‘abject’, and *abierto* [aβ’i̯erto] ‘opened’ (Saporta (1956)).

Approximant-Vowel Correspondences (Ladefoged and Maddieson (1996), Martinez-Celdran (2004))

1. Vowel – i; Corresponding Approximant – j:
    a. Place of Articulation – Palatal
    b. Example – Spanish *ampl**í**o* ‘I extend’ vs. *ampl**ió*** ‘he extended’
2. Vowel – ɯ; Corresponding Approximant – ɰ:
    a. Place of Articulation – Velar
3. Lip Spreading in [i ɯ] Articulation: Because the vowels [i ɯ] are articulated with spread lips, spreading is implied for their approximant analogues [j ɰ]. However, these sounds generally have little to no lip-spreading.
4. Neutral between Spread and Rounded: The fricative letters with a lowering diacritic <j̞ ɣ̞> may therefore be justified for a neutral articulation between [j ɰ] and [ɥ w] (Esling (2010)).
5. Vowel – y; Corresponding Approximant – ɥ:
    a. Place of Articulation – Labio-palatal
    b. Example – French *aig**u*** ‘sharp’ vs. *aig**u**ille* ‘needle’
6. Vowel – u; Corresponding Approximant – w:
    a. Place of Articulation – Labio-velar
    b. Example – Spanish *contin**ú**o* ‘I continue vs. *contin**u**ó* ‘he continued
7. Vowel – a; Corresponding Approximant – ʕ̞:
    a. Place of Articulation – Pharyngeal
8. Vowel – ɚ; Corresponding Approximant – ɹ:
    a. Place of Articulation – Postalveolar, retroflex
    b. Example – English *wait**er*** vs. *wait**r**ess*
9. American English Rhotic Articulatory Vowels: Because of the articulatory complexities of the American English rhotic, there is some variation in its phonetic description.
10. Palatal/Velar/Labialized Approximant Articulation: In articulation, and often diachronically, palatal approximants correspond to front vowels, velar approximants to back vowels, and labialized approximants to rounded vowels.

11. Glide Insertion Adjacent to Hiatus: In addition to the alternations, glides can be inserted to the left or to the right of their corresponding vowels when they occur next to a hiatus (Rubach (2002)).
12. Glide Insertion Example in Ukrainian: For example, in Ukrainian the medial /i/ triggers the formation of an inserted [j]that acts as a syllable onset so that when the affix /-ist/ is added to 'football' to make 'football player', it is pronounced [futbo̯'list], but 'Maoist', with the same affix, is pronounced [mao̯'ʝist] with a glide (Rubach (2002)).
13. Glide Insertion Example in Dutch: Dutch for many speakers has a similar process that extends to mid-vowels (Rubach (2002)):
    a. *bioscoop* – ['bi**j**ɔsko:p] 'cinema'
    b. *zee + en* – [ze:**j**ə(n)] 'seas'
    c. *fluor* – [fly**ɥ**ɔr] 'fluor'
    d. *reu + en* – [rø**ɥ**ə(n)] 'male dogs'
    e. *Rwanda* – [ru**ʋ**anda] 'Rwanda'
    f. *Boaz* – [bo**ʋ**as] 'Boaz'
14. Dialectal and Allophonic Variation of [ʋ]: There is dialectal and allophonic variation in the realization of [ʋ]. For speakers who realize it as [ʋ], Rubach (2002) postulates an additional rule that changes any occurrence of [w] from glide insertion into [ʋ].
15. Vowel Insertion Adjacent to Glides: Similarly, vowels can be inserted next to their corresponding glides in certain phonetic environments. Siever's law describes this behavior for Germanic languages.
16. Occurrence of Non-high Semivowels: Non-high semivowels also occur. In colloquial Nepali speech, a process of glide formation occurs, where one of two adjacent vowels become non-syllabic; the process includes mid-vowels so that [dʱo̯a] 'cause to wish' features a non-syllabic mid-vowel (Ladefoged and Maddieson (1996)).
17. Non-high Semivowels in Spanish: Spanish features a similar process and even non-syllabic /a/ can occur so that *ahorita* – 'right away' – is pronounced [a̯o̯'ɾita] (Martinez-Celdran, Fernandez-Planas, and Carrera-Sabate (2003)).
18. Distinction between Semivowel and Diphthong: It is often not clear, however, whether such sequences involve a semivowel – a consonant, or a diphthong – a vowel, and in many cases, it may not be a meaningful distinction.

19. Approximants corresponding to Central Vowels: Although many languages have central vowels [ɨ ʉ], which lie between that back/velar [ɯ u] and front/palatal [i y], there are a few cases of a\the corresponding approximant [j̈].
20. Examples in Korean and Mapudungan: One is in the Korean diphthong [j̈ i] or [ɨ̯ i] (Ahn and Iverson (2006)) although it is more frequently analyzed as a velar as in the section above – and Mapudungan may be another, with three high-vowel sounds /i/, /u/, /ɨ/, and three corresponding consonants /j/ and /w/, and a third one is often described as a voiced unrounded velar fricative; some texts note a correspondence between this approximant and /ɨ/ that is parallel to /j/ - /i/ and /w/ - /u/. An example is *liq* / ’liɣ / [‘liɨ̯]? ‘white’.

Approximants Versus Fricatives

1. Precision Required to Deliver Frication: In addition to less turbulence, approximants also differ from fricatives in the precision required to produce them (Boersma (1997)).
2. Slightly Fricated Articulation of Approximants: When emphasized, approximants may be slightly fricated, that is, the airstream may become slightly turbulent, which is reminiscent of fricatives.
3. Fricatization During Emphatic Speech: For example, the Spanish word *ayuda* ‘help’ features a palatal approximant that is pronounced as a fricative in emphatic speech (Martinez-Celdran (2004)).
4. Distinction between Fricative/Approximant/Intermediate: Spanish can be analyzed as having a meaningful distinction between fricative, approximant, and intermediate /ʝ ʝ̞ j/ (Martinez-Celdran (2004)). However, such frication is generally slight and intermittent, unlike the strong turbulence of fricative consonants.
5. Back-of-mouth Fricatives/Approximants: For places of articulation further back in the mouth, languages do not contrast voiced fricatives and approximants. Therefore, IPA allows for voiced fricatives to double for the approximants, with or without a lowering diacritic.

6. Glottal Fricatives versus Approximants: Occasionally, the glottal *fricatives* are called approximants, since [h] typically has no more frication than voiceless approximants, but they are often phonations of the glottis without accompanying manner of place of articulation.

Central Approximants

1. Bilabial Approximant [β̞]: Usually transcribed <β>.
2. Labiodental Approximant [ʋ]
3. Dental Approximant <ð̞>: Usually transcribed <ð>
4. Alveolar Approximant [ɹ]:
5. Retroflex Approximant [ɻ]: A consonantal [ɚ]
6. Palatal Approximant [j]: A consonantal [i]
7. Velar Approximant [ɰ]: A consonantal [ɯ]
8. Uvular Approximant [ʁ̞]: Usually transcribed <ʁ>
9. Pharyngeal Approximant [ʕ̞]: A consonantal [a]; usually transcribed <ʕ>
10. Breathy-voiced Glottal Approximant [ɦ]
11. Creaky-voiced Glottal Approximant [ʔ̞]
12. IPA Symbols [β̞] and [ð̞]: There have been repeated requests that the IPA create dedicated symbols for [β̞] and [ð̞] – typically modifications of the base letters turned or reversed <> or <ð> - but so far, the IPA has deemed that there is insufficient need for them.

Lateral Approximants

1. Center of Tongue vs. Side: In lateral approximants, the center of tongue makes solid contact with the roof of the mouth. However, the defining location is the side of the tongue, which only approaches the teeth, allowing free passage of air.
2. Voiced Alveolar Lateral Approximant [l]
3. Retroflex Lateral Approximant [ɭ]
4. Voiced Palatal Lateral Approximant [ʎ]
5. Velar Lateral Approximant [ʟ]
6. Uvular Lateral Approximant [ʟ̠]

Coarticulated Approximants with Dedicated IPA Symbols

1. Labialized Velar Approximant [w]: A consonantal [u]
2. Labialized Palatal Approximant [ɥ] or [jʷ]: A consonantal [ɥ]

Voiceless Approximants

Voiceless approximants are not recognized by all phoneticians as a discrete phonetic category. There are problems in distinguishing voiceless approximants from voiceless fricatives.

Disagreement over the Use of the Term

1. <u>Voiceless Lateral Approximants and Fricatives</u>: Ladefoged and Maddieson (1996) agree that Burmese and Standard Tibetan have voiceless lateral approximants [l̥] and Navajo and Zulu voiceless lateral fricatives [ɬ], but also say that "in other cases it is difficult to decide whether a voiceless lateral should be described as an approximant or a fricative".
2. <u>Range of Voiceless Lateral Variants</u>: Asu, Nolan, and Schotz (2015) compared voiceless laterals in Estonian Swedish, Icelandic, and Welsh, and found "the existence of a range of variants within voiceless laterals rather than a categorical split between lateral fricatives and voiceless approximant laterals".

Phonetic Characteristics

1. <u>Turbulent Airflow at Place of Articulation</u>: Fricative consonants are generally said to be the result of turbulent airflow at the place of articulation in the vocal tract (Ashby and Maidment (2005)).
2. <u>Non-turbulent but Voiceless Audible Sound</u>: However, an audible voiceless sound may be made without this turbulent airflow: (Pike (1943)) makes a distinction between *local friction* as in [s] and [z] and *cavity friction* in voiceless vowels like [ḁ] and [ɔ̥].
3. <u>Laminar vs. Turbulent Airflow</u>: More recent research distinguishes between *turbulent* and *laminar* airflow in the vocal tract (Shadle (2000)). It is not clear if it is possible to describe voiceless approximants categorically as having laminar airflow – or cavity friction in Pike's terms – as a way of distinguishing them from fricatives.
4. <u>Observation of Ball and Rahilly</u>: Ball and Rahilly (1999) note that "airflow for voiced approximants remain laminar/smooth, and does not become turbulent. Voiceless approximants are rare in the languages of the world, but when they do occur the airflow is usually somewhat turbulent".
5. <u>Audible, Voiceless Sounds at Glottis</u>: Audible voiceless sounds may also be produced by means of turbulent airflow at the glottis, as in [h]: in such as case, it is possible to articulate

an audible voiceless sound without the production of local friction at the supraglottal constriction. Catford (1977) describes such sounds, but classes them as sonorants.

Distinctiveness

1. Distinguishing Voiceless Fricatives from Voiceless Approximants: Voiceless approximants are rarely, if ever, distinguished phonemically from voiceless fricatives in the sound system of a language.
2. Observation of Clark and Yallop: Clark and Yallop (1995) discuss the issue and conclude: "In practice, it is difficult to distinguish a voiceless approximant from a voiceless fricative at the same place of articulation … there is no evidence that any language in the world makes such a distinction crucial".

Nasal Approximants

1. Nasal Continuant – Synonym of Nasal Consonant: Nasal approximants are not nasal continuants, which is a synonym for nasal consonants. The following are examples.
2. Nasal Palatal Approximant [j̃]
3. Nasal Labialized Velar Approximant [w̃]
4. Voiceless Nasal Glottal Approximant [h̃]
5. Examples from Portuguese and Edo: In Portuguese, the nasal glides [j̃] and [w̃] historically became /ɲ/ and /m/ in some words. In Edo, the nasalized allophones of the approximants /j/ and /w/ are nasal occlusives [ɲ] and [ŋʷ].
6. Inclusion of Nasal Vowels/Diphthongs: What are transcribed as nasal approximants may include non-syllabic elements of nasal vowels or diphthongs.

References

- Ahn, C. K., and G. K. Iverson (2006): Structured Imbalances in the Emergence of the Korean Vowel System **University of Wisconsin** Madison, WI
- Ashby, M., and J. Maidment (2005): *Introducing Phonetic Science* **Cambridge University Press** Cambridge, UK
- Asu, E. L., F. Nolan, and S. Schotz (2015): *A Comparative Study of Estonian Swedish Voiceless Laterals: Are Voiceless Approximants Fricatives?* **University of Glasgow Press** Glasgow, UK
- Ball, M., and J. Rahilly (1999): *Phonetics: The Science of Speech* **Arnold** London, UK
- Boersma, P. (1997): *Functional Phonology: Formalizing the Interactions between Articulatory and Perceptual Drives* **Holland Academic Graphs** Den Haag, Netherlands
- Catford, J. C. (1977): *Fundamental Problems in Phonetics* **Edinburgh University Press** Edinburgh, UK
- Clark, J., and C. Yallop (1995): *An Introduction to Phonetics and Phonology 2nd Edition* **Wiley-Blackwell** Hoboken, NJ
- Esling. J. (2010): Phonetic Notation, in: *The Handbook of Phonetic Sciences 2nd Edition Editors: Hardcastle, W. J., J. Laver, and F. E. Gibbon* **Wiley-Blackwell** Hoboken, NJ
- Hall, T. A. (2007): Segmental Features, in: *Cambridge Handbook of Phonology (Editor: P. de Lacy)* **Cambridge University Press** Cambridge, UK
- Kawasaki, H. (1982): *An Acoustic Basis for Universal Constraints on Sound Sequences* **University of California** Berkeley, CA
- Ladefoged, P. (1964): *A Phonetic Study of West African Languages* **Cambridge University** Cambridge, UK
- Ladefoged, P. (1975): *A Course in Phonetics* **Harcourt Brace Jovanovich** New York, NY
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK

- Maddieson, I., and K. Emmorey (1985): Relationship between Semivowels and Vowels: Cross-linguistic Investigations of Acoustic Difference and Co-articulation *Phonetic* **42 (4)** 163-174
- Martinez-Celdran, E., A. M. Fernandez-Planas, J. Carrera-Sabate (2003): Castillian Spanish *Journal of the International Phonetic Association* **33 (2)** 255-259
- Martinez-Celdran, E. (2004): Problems in the Classification of Approximants *Journal of the International Phonetic Association* **34 (2)** 201-210
- Montreuil, J. P. (2004): From Velar Codas to High Nuclei: Phonetic and Structural Change in OT *Probus* **16 (1)** 91-111
- Pike, K. (1943): *Phonetics* **University of Michigan Press** Ann Arbor, MI
- Rubach J. (2002): Against Subsegmental Glides *Linguistic Inquiry* **33 (4)** 672-687
- Saporta, S. (1956): A Note on Spanish Semivowels *Language* **32 (2)** 287-290
- Shadle. C. (2010): The Aerodynamics of Speech, in: *The Handbook of Phonetic Sciences Editors: Hardcastle, W. J., and J. Laver* **Wiley-Blackwell** Hoboken, NJ
- Wikipedia (2021): Approximant

Semivowel

Overview

1. Definition of a Semivowel/Glide: A *semivowel* or *glide* is a sound that is phonetically similar to a vowel sound, but functions as a syllable boundary rather than as the nucleus of a syllable (Ladefoged and Maddieson (1996), Wikipedia (2021)).
2. Examples of Semivowels in English: Examples of semivowels in English are the consonants *y* and *w*, in *yes* and *west*, respectively. Written /j w/ in IPA, *y* and *w* are near to the vowels *ee* and *oo* in *seen* and *moon*, written /iː uː/ in IPA.
3. Glide as a Generic Transitional Sound: The term *glide* may alternatively refer to any type of transitional sound, not necessarily a semivowel (Crystal (2008)).

Classification

1. Distinction between Semivowel and Approximant: Semivowels form a subclass of approximants (Martinez-Celdran (2004), Crystal (2008)). Although *semivowels* and *approximants* are sometimes treated as synonyms (Meyer (2005)), most authors use the term *approximant* for a more restricted set; there is no universally agreed-upon definition, and the exact details may vary from author to author.
2. Labiodental Approximant as a Semivowel: For example, Ladefoged and Maddieson (1996) do not consider the labiodental approximant [ʋ] to be a semivowel, while Martinez-Celdran (2004) proposes that it should be considered one.

3. <u>IPA Diacritics for Non-syllabic Vowels</u>: In the International Phonetic Alphabet, the diacritic attached to non-syllabic vowel letters is an inverted breve placed below the symbol representing the vowel: U+032F ̯ COMBINING INVERTED BREVE BELOW.
4. <u>The Combining Inverted Breve</u>: When there is no room for the tack under a symbol, it may be written above, using U+0311 ̑ COMBINING INVERTED BREVE. Before 1989, non-syllabicity was represented by U+0306 COMBINING BREVE, which now stands for extra-shortness.
5. <u>Semivowels corresponding to Cardinal Vowels</u>: Additionally, there are dedicated symbols for 4 semivowels that correspond to the 4 close cardinal vowel sounds (Martinez-Celdran (2004)).
6. <u>Palatal Approximant</u>:
    a. Semivowel (non-syllabic) - [j]
    b. Syllabic Vowel – [i]; Close Front Unrounded Vowel
7. <u>Labio-palatal Approximant</u>:
    a. Semivowel (non-syllabic) - [ɥ]
    b. Syllabic Vowel – [y]; Close Front Rounded Vowel
8. <u>Velar Approximant</u>:
    a. Semivowel (non-syllabic) - [ɰ]
    b. Syllabic Vowel – [ɯ]; Close Back Unrounded Vowel
9. <u>Labiovelar Approximant</u>:
    a. Semivowel (non-syllabic) - [w]
    b. Syllabic Vowel – [u]; Close Back Rounded Vowel
10. <u>Open Back Unrounded Vowel Approximants</u>: The pharyngeal approximant [ʕ̞] is also equivalent to he semivowel articulation of the open back unrounded vowel [ɑ] (Ladefoged and Maddieson (1996)).
11. <u>Rhotic Approximants as Semivowels</u>: In addition, some authors (Ladefoged and Maddieson (1996), Martinez-Celdran (2004)) consider rhotic approximants [ɹ], [ɻ] to be semivowels corresponding to R-colored vowels such as [ɚ].
12. <u>Case of Labiodental Approximants</u>: As mentioned above, the labiodental approximant [ʋ] is considered a semivowel in some treatments.

13. Occurrence of Unrounded/Rounded Central Semivowels: An unrounded central semivowel, [j̈] – or [j-] – equivalent to [ɨ], is uncommon, though rounded [ẅ] – or [w̝] – equivalent to [ʉ], is found in Swedish and Norwegian.

Contrast with Vowels

1. Comparison between Vowels and Semivowels: Semivowels, by definition, contrast with vowels by being non-syllabic. In addition, they are usually shorter than vowels (Crystal (2008)).
2. Narrower Constriction in Vocal Tract: In languages as diverse as Amharic, Yoruba, and Zuni, semivowels are produced with a narrower constriction in the vocal tract than their corresponding vowels (Ladefoged and Maddieson (1996)).
3. Phonemic Equivalence between Semivowels/Vowels: Nevertheless, semivowels may be phonemically equivalent with vowels. For example, the English word *fly* can be considered either as an open syllable ending in a diphthong [flaɪ̯] or as a closed syllable ending in a consonant [flaj] (Cohen (1971)).
4. Contrasting Diphthongs and Semivowels: It is unusual for a language to contrast a semivowel with a diphthong containing an equivalent vowel, but Romanian contrasts the diphthong /e̯a/ with /ja/, a perceptually similar approximant-vowel sequence.
5. Segmental Comparison between Diphthongs and Approximants: The diphthong is analyzed as a single segment, and the approximant-vowel sequence is analyzed as two separate segments.
6. Phonetic Differences between Diphthongs and Semivowels: In addition to the phonological justifications for the distinction – such as the diphthong alternating with /e/ in singular-plural pairs, there are phonetic differences between the pairs (Chitoran (2002)).
7. Approximant has a Greater Duration: /ja/ has a greater duration than /e̯a/.

8. Longer/Faster Transition for Approximants: The transition between the two elements in longer and faster for /ja/ than /e̯a/ with the former having a higher F2 onset, i.e., greater constriction of the articulators.
9. Analogue between /o̯a/ and /wa/: Although a phonological parallel exists between /o̯a/ and /wa/, the production and the perception of phonetic contrasts between the two is much weaker, likely because of the lower lexical load for /wa/, which is limited largely to loanwords from French, and speakers' difficulty in maintaining contrasts between two back rounded semivowels in comparison to front ones (Chitoran (2002)).

Contrast with Fricatives/Spirant Approximants

1. Turbulence of Fricatives vs. Semivowels: According to the standard definitions, semivowels such as [j] contrast with fricatives such as [ʝ] in that, fricatives produce turbulence, whereas semivowels do not.
2. Spirant Approximants - between Fricatives and Approximants: In discussing Spanish, Martinez-Celdran (2004) suggests setting up a third category of "spirant approximant" contrasting both with semivowel approximants and with fricatives.
3. Spirant Approximant Constriction and Rounding: Though the spirant approximant is more constricted, i.e., having a lower F2 amplitude, linger and unspecified for rounding – *viuda* ['b**ju**ða] 'widow' vs. *ayuda* [a'**ʝ**ʷ**u**ða] 'help' – the distributional overlap is limited.
4. Occurrence During Syllable Onset: The spirant approximant can only appear in the syllable onset, including word-initially, where the semivowel never appears.
5. Distributional Overlap with Semivowel Approximant: The two overlap in /l/ and /n/: *enyesar* [ẽɲ**ʝ**e'saɾ], 'to plaster'; *aniego* [a'n**j**eɣo] 'flood' (Trager (1942)), and although there is dialectal and idiolectal variation, speakers also exhibit other near-minimal pairs like *ab**ye**cto* 'abject' vs. *ab**ie**rto* 'opened' (Saporta (1956)).

6. <u>Minimal Pairs Distinguishing these Approximants</u>: One potential minimal pair – depending on dialect – is *ya visto* [**(ɟ)ja̯**'βisto] 'already seen' vs *y ha visto* [**ja̯**'βisto] 'and he has seen' (Bowen and Stockwell (1955)). Again, it is not present in all dialects.
7. <u>Reduction or Enhancement of Contrast</u>: Other dialects differ in either merging the two or enhancing the contrast by moving the former to another place of articulation [ʒ], like in Rioplatense Spanish.

References

- Bowen, J. D., and R. P. Stockwell (1955): The Phonemic Interpretation of Semivowels in Spanish *Language* **31 (2)** 236-240
- Chitoran, I. (2002): A Perception-Production Study of Romanian Diphthongs and Glide-Vowel Sequences *Journal of the International Phonetic Association* **32 (2)** 203-222
- Cohen, A. (1971): *The Phonemes of English: A Phonemic Study of Vowels and Consonants of Standard English 3rd Edition* **Springer** New York, NY
- Crystal, D. (2008): *A Dictionary of Linguistics and Phonetics 6th Edition* **Blackwell** Oxford, UK
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Martinez-Celdran, E. (2004): Problems in the Classification of Approximants *Journal of the International Phonetic Association* **34 (2)** 201-210
- Meyer, P. G. (2005): *Synchronic English Linguistics: An Introduction 3rd Edition* **Gunter Narr Verlag** Tubingen, Germany
- Saporta, S. (1956): A Note on Spanish Semivowels *Language* **32 (2)** 287-290
- Trager, G. (1942): The Phonemic Treatment of Semivowels *Language* **18 (3)** 220-223
- Wikipedia (2021): Semivowel

Continuant

1. Partially/Fully Open Oral Cavity: A *continuant* is a speech sound produced without a complete closure in the oral cavity, namely fricatives, approximants and vowels (Wikipedia (2020)).
2. Term Used for Consonant Sounds: While vowels are included in continuants, the term is often reserved for consonant sounds (Chalker (1998)).
3. Approximants as Frictionless Continuants: Approximants were traditionally called "frictionless consonants".
4. Contrasting Continuants against Occlusives: Continuants contrast with occlusives, such as plosives, fricatives, and nasals.
5. Comparison between Sonorants and Continuants: Compare sonorant/resonant, which includes vowels, approximants, and nasals but not fricatives, and contrasts with obstruent.
6. Inclusion of Trills and Lateral Variants: In phonology, continuant as a distinctive feature also includes trills. Whether lateral fricatives and approximants and taps/flaps are continuant is not conclusive (Hayes (2009)).

References

- Chalker, S. (1998): *The Oxford Dictionary of English Grammar* **Oxford University Press** Oxford, UK
- Hayes, B. (1996): *Introductory Phonology* **Blackwell** Oxford, UK
- Wikipedia (2020): Continuant

Lateral Consonant

Overview

1. Definition of the Lateral Consonant: A *lateral* is a consonant in which the airstream proceeds along the sides of the tongue, but it is blocked by the tongue from going through the middle of the mouth. An example of the lateral consonant is the English *L*, as in *Larry* (Wikipedia (2021)).
2. Contrasting Laterals with Central Consonants: Lateral consonants contrast with central consonants, in which the airstream flows through the center of the mouth.
3. Dental and Alveolar Lateral Consonants: For the most common laterals, the tip of the tongue makes contact with the upper teeth, i.e., the dental consonant, or the upper gun, i.e., the alveolar consonant, but there are many other possible places for the laterals to be made.
4. Lateral Liquids, Fricatives, and Affricates: The most common laterals are approximants and belong to the class of liquids, but lateral fricatives and affricates are also common in some parts of the world.
5. Additional Variants - Lateral Flaps/Clicks: Some languages, such as the Iwaidja and the Ilgar languages of Australia, have lateral flaps, and others, such as Xhosa and Zulu languages of Africa, have lateral clicks.
6. The Case of Labiodental Fricatives: When pronouncing the labiodental fricatives [f] and [v], the lip blocks the airflow in the center of the vocal tract, so the airstream proceeds along the sides instead. Nevertheless, they are not considered lateral consonants because the airflow never goes over the sides of the tongue.
7. Distinction between Lateral/Non-lateral Labiodentals: No known language makes a distinction between lateral and non-lateral labiodentals.

8. Conjunction of Plosives with Laterals: Plosives are never lateral, but they may have a lateral release.
9. Conjunction of Nasals with Laterals: Nasals are never laterals either, but some languages have nasal lateral clicks.
10. Conjunction of Laryngeals with Laterals: For consonants articulated in the throat, i.e., the laryngeals, the lateral distinction is not made by any language, although pharyngeal and epiglottal laterals are reportedly possible (Ladefoged and Maddieson (1996)).

Examples

1. English has One Lateral Phoneme: This is the lateral approximant /l/, which in many accents has two allophones.
2. Alveolar Lateral Approximant - Clear [l]: One, found before vowels as in *lady* or *fly*, is called *clear l*, pronounced as the alveolar lateral approximant [l] with a *neutral* position of the body of the tongue.
3. Velarized Alveolar Lateral Approximant - Dark [ɫ]: The other variant, so-called *dark [l]*, found before consonants or word-finally, as in *bold* or *tell*, is pronounced as the velarized alveolar lateral approximant [ɫ] with the tongue assuming a spoon-like shape with its back part raised, which gives the sound a [w] – or [ʟ] – like resonance.
4. Languages with Different Lateral Phonemes: In some languages, like Albanian, those two sounds are different phonemes. East Slavic languages contrast [ɫ] with [lʲ] and do not have [l].
5. Reducing Transformation of Dark [ɫ]: In many British accents, e.g., Cockney, dark [ɫ] may undergo vocalization through reduction and loss of contact between the tip of the tongue and the alveolar ridge, becoming a rounded back vowel or glide. This process turns *tell* into [tɛɰ], as must have happened with *talk* [tɔ:k] or *walk* [wɔ:k] at some stage.
6. Dark [ɫ] Transformation across Languages: A similar process happened during the development in many other languages, including Brazilian Portuguese, Old French, and

Polish, in all three of these resulting in the voice velar approximant [ɰ] or voiced labio-velar approximant [w], examples being modern English *sauce* as compared with Spanish *salsa*, or Polish *Wisla* – pronounced [viswa] – as compared with English *Vistula*.

7. Intervocalic /l/ in Venetian Dialects: In Central and Venice dialects of Venetian, intervocalic /l/ has turned into a semi-vocalic [e̯], so that the written word *ła bała* is pronounced [abae̯a].
8. Orthographic Representation of Intervocalic /l/: The orthography uses the letter [ł] to represent this phoneme; it specifically represents not the [e̯] sound but phoneme is, in some dialects, [e̯] and, in others, [l].
9. Languages with Multiple Lateral Approximants: Many aboriginal Australian languages have a series of three or four lateral approximants, as do various dialects of Irish.
10. Instances of Rare Lateral Consonants: Rare lateral consonants include the retroflex laterals can be found in many languages of India and in some Swedish dialects, and the voiceless alveolar lateral fricatives /ɬ/, found in many Native American languages, Welsh and Zulu.
11. Voiced/Voiceless Alveolar Lateral Fricatives: In Adyghe and some Athabaskan languages like Han, both voiceless and voiced alveolar lateral fricatives occur, but there is no approximant. Many of these languages also have lateral affricates.
12. Palatal/Velar Lateral Fricatives/Affricatives: Some languages have palatal or velar voiceless lateral fricatives or affricates, such as Dahalo and Zulu, but the IPA has no symbols for such sounds.
13. Improvization for Lack of Symbology: However, appropriate symbols are easy to make by adding a lateral-fricative belt to the symbol for the corresponding lateral approximant – see below. Also, a devoicing diacritic may be added to the approximant.
14. Lateral Obstruents without the Approximant: Nearly all languages with such lateral obstruents also have the approximant. However, there are a number of exceptions, many of them located in the Pacific Northwest area of the United States.
15. Laterals in the Tlingit Language: For example, /tɬ, tɬʰ, tɬ’, ɬ, ɬ‘/ but no /l/. Some older Tlingit speakers have [l], as an allophone of /n/. This can also be analyzed as phonemic /l/ with an allophone [n].
16. Other Laterals from Pacific Northwest: Other examples from the same area include Nuuchah-nulth and Kutenai, and elsewhere, Chukchi and Kabardian.

17. Lateral Approximant in Standard Tibetan: Standard Tibetan has a voiceless lateral approximant, usually Romanized as *lh*, as in the name Lhasa.
18. American English Uvular Lateral Approximant: An uvular lateral approximant has been reported to occur in some speakers of American English (Gimson and Cruttenden (2014)).
19. Retroflex Lateral/Approximant in Pashto: Pashto has a retroflex lateral flap that becomes voiced retroflex approximant when it is at the end of a syllable and a word.
20. Occurrence of Lateral Click Consonants: There are a large number of lateral click consonants: 17 occur in !Xóõ.
21. Existence of Lateral Trills: Lateral trills are also possible, but they do not occur in any known language. They may be pronounced by initiating [ɬ] or [ɮ] with an especially forceful airflow.
22. IPA Symbol for Lateral Trill: There is no symbol for lateral trills in the IPA. They are sometimes used to imitate bird calls, and they are a component of Donald Duck talk.

List of Laterals – Approximants

1. Voiced Dental Lateral Approximant [l̪]
2. Voice Alveolar Lateral Approximant [l]
3. Voiced Retroflex Lateral Approximant [ɭ]
4. Voiced Palatal Lateral Approximant [ʎ]
5. Voiced Velar Lateral Approximant [ʟ]
6. Voiced Uvular Lateral Approximant [ʟ̠]

List of Laterals – Fricatives

1. Voiceless Dental Lateral Fricative [ɬ̪]: In Wahgi

2. <u>Voiced Dental Lateral Fricative [ɮ̪]</u>: Allophonic in Wahgi
3. <u>Voiceless Alveolar Lateral Fricative [ɬ]</u>: In Adyghe, Kabardian, Navajo, Welsh
4. <u>Voiced Alveolar Lateral Fricative [ɮ]</u>: In Adyghe, Kabardian, Mongolian, Tigak
5. <u>Voiceless Retroflex Lateral Fricative [ꞎ]</u>: In Toda
6. <u>Voiced Retroflex Lateral Fricative [ɭ˔]</u>: In Ao
7. <u>Voiceless Palatal Lateral Fricative [ʎ̝̊]</u>: In Dahalo, Inupiaq
8. <u>Voiced Palatal Lateral Fricative [ʎ̥]</u>: Allophonic in Jebero
9. <u>Voiceless Velar Lateral Fricative [ʟ̝̊]</u>: In Archi, Nii, Wahgi
10. <u>Voiceless Velar Lateral Fricative [ʟ̝]</u>: In Archi, allophonic in Wahgi
11. <u>Dedicated Symbols for Alveolar Lateral Fricatives</u>: Only the alveolar lateral fricatives have dedicated letters in the IPA. However, others appear in the extIPA.

List of Laterals – Affricates

1. <u>Voiceless Alveolar Lateral Affricate [ʈɬ]</u>: In Navajo, Tlingit
2. <u>Voiced Alveolar Lateral Affricate [dɮ]</u>: Allophonic in Zulu and Xhosa
3. <u>Voiceless Retroflex Lateral Affricate [ʈɬ]</u>: In Kamkata-vari
4. <u>Voiced Retroflex Lateral Affricate [ɖɭ˔]</u>: In Kamkata-vari
5. <u>Voiceless Palatal Lateral Affricate [ɟʎ̝]</u>: Possibly pre-palatal in Sandawe
6. <u>Voiceless Velar Lateral Affricate [kʟ̝̊]</u>: In Archi, Laghuu, Muji
7. <u>Voiced Velar Lateral Affricate [ɡʟ̝]</u>: In Archi, Laghuu, Muji

List of Laterals – Flaps

1. <u>Voiceless Alveolar Lateral Flap [ɺ̥]</u>: In Yavitero (Mosonyi, Mosonyi, and Esteban (2000))

2. Voiceless Alveolar Lateral Flap [ɺ]: In Wayuu
3. Voiced Alveolar Lateral Flap [l̥̆]: Allophonic in Wahgi
4. Voiced Retroflex Lateral Flap [ɭ̆]: In Pashto, Iwaidja
5. Palatal Lateral Flap [ʎ̆]: Allophonic in Iwaidja and Ilgar
6. Velar Lateral Flap [ʟ̆]: In Kanite and Melpa

List of Laterals – Ejective Fricatives

1. Alveolar Lateral Ejective Fricative [ɬ’]: In Adyghe, Kabardian, Tlingit
2. Retroflex Lateral Ejective Fricative [ꞎ’]
3. Palatal Lateral Ejective Fricative [ʎ̝̊’]
4. Velar Lateral Ejective Fricative [ʟ̝̊’]
5. Ejective Fricatives in Natural Languages: Only the alveolar [ɬ’] has been attested in natural languages.

List of Laterals – Ejective Affricates

1. Alveolar Lateral Ejective Affricate [t͜ɬ’]: In Baslaney, Navajo, Tlingit
2. Palatal Lateral Ejective Affricate [cʎ̝̊’]: In Dahalo, Sandawe, Hadza
3. Velar Lateral Ejective Affricate [kʟ̝̊’]: In Archi, G|wi, Zulu

List of Laterals – Ejective Clicks

Alveolar Lateral clicks [ᵏ||], [ᶢ||], [ᵑ̩||], [||], [ᴺ||] etc. – in all five Khoisan and several Bantu languages.

Ambiguous Centrality

1. Centrality-based IPA Sound Definition: The IPA requires sounds to be defined as to centrality, as either central or lateral. However, languages may be ambiguous as to some consonants' laterality (Ladefoged and Maddieson (1996)).
2. Example - Liquid Consonant in Japanese: A well-known example is the liquid consonant in Japanese, represented in common transliteration systems as <r>, which can be recognized as a (post-) alveolar tap (Okada (1999)), alveolar lateral flap, (post-) alveolar lateral approximant, (post-) alveolar approximant, voiced retroflex stop (Arai, Warner, and Greenberg (2007)), and various less common forms.

Lateralized Consonants

1. A superscript <ˡ> is defined as a lateral release.
2. Consonants with Lateral + Central Airflow: Consonants may be pronounced with simultaneous lateral and central airflow.
3. Occurrence in Non-disordered Speech: However, it also occurs in non-disordered speech in some Southern Arabic dialects and possibly some modern South Arabian languages, which have pharyngealized non-sibilant /ls̪ˤ/ and /lz̪ˤ/ - simultaneous [θ͜ɬˤ] and [ð͡ɮˤ] – and possibly a sibilant /ls/, i.e., simultaneous [s͜ɬ].

4. <u>Occurrence Instances in Arabian Dialects</u>: Examples are /θˡˤaim/ ‘pain’ in the dialect of Al-Rubua’h and /ðˡˤahr/ ‘back’ and /ðˡˤabʕ/ ‘hyena’ in Rijal Alma’a (Watson and Al Azraqi (2011), Heselwood (2013)). Here the <ˡ> indicates simultaneous laterality rather than lateral release.
5. <u>Occurrence in Old Arabic</u>: Old Arabic has been analyzed as having the emphatic central-lateral fricatives [θ͜ɬˤ], [ð͡ɮˤ], and [ʃ͡ɬˤ] (Potet (2013)).

References

- Arai, T., N. Warner, and S. Greenberg (2007): Analysis of Spontaneous Japanese in a Multi-language Telephone-Speech Corpus *Acoustical Science and Technology* **28 (1)** 46-48
- Gimson, A. C., and A. Cruttenden (2014): *Gimson’s Pronunciation of English 8th Edition* **Routledge** Oxfordshire, UK
- Heselwood, B. (2013): Phonetic Transcription in Theory and Practice
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World’s Languages* **Blackwell** Oxford, UK
- Mosonyi, E., J. Mosonyi, and A. Largo (2000): Yavitero, in: *Manual de Lenguas Indigenas de Venezuela (Editors: E. Mosonyi and J. Mosonyi) Tomo 2* **Universidad Central de Venezuela** Caracas, Venezuela
- Okada, H. (1999): *Handbook of the International Phonetic Association: A Guide to the Use of the International Phonetic Alphabet* **Cambridge University Press** Cambridge, UK
- Potet, J. G. (2013): Arabic and Persian Loanwords in Tagalog
- Watson, J. and M. Al Azraqi (2011): Lateral Fricatives and Lateral Emphatics in Southern Saudi Arabia and Mehri
- Wikipedia (2021): Lateral Consonant

Vibrant Consonant

1. Definition of a Vibrant Consonant: A vibrant isa class of consonants including taps and trills – a trill is sometimes referred to as a vibrant consonant (Nicolosi, Harryman, and Kresheck (2004), Wikipedia (2021)). Spanish has two vibrants, /r/ and /ɾ/.
2. Used as Substitute for Rhotics: The term is sometimes used when it is not clear whether the rhotic r-sound in a language is a tap or a trill.

References

- Nicolosi, L., E. Harryman, and J. Kresheck (2004): *Terminology of Communication Disorders* **Lippincott Williams and Wilkin** Philadelphia, PA
- Wikipedia (2021): Vibrant Consonant

Trill Consonant

Overview

1. Mechanics of Trill Production: A *trill* is a consonantal sound produced by vibrations between the active articulator and the passive articulator. Standard Spanish <rr> as in *perro*, for example, is an alveolar trill (Wikipedia (2021)).
2. Placement of Articulator and Airstream: A trill is made by the articulator being held in place and the airstream causing it to vibrate.
3. Contacts needed to Construct Trills: Usually a trill vibrates for 2-3 contacts, but may be up to 5, or even more if geminate (Ladefoged and Maddieson (1996)). However, trills may also be produced with only one contact.
4. Contrasts with Tap or Flap: While single contact trills are similar to taps and flaps, a tap or a flap differs from a trill in that it is made by muscular contraction rather than airstream (Ladefoged and Johnson (2010)).

Phonemic Trills

1. Following trills are included in the IPA
2. Alveolar Trill [r]
3. Voiceless Alveolar Trill [r̥]
4. Bilabial Trill [ʙ]
5. Voiceless Bilabial Trill [ʙ̥]

6. <u>Uvular Trill [ʀ]</u>
7. <u>Voiceless Uvular Trill [ʀ̥]</u>
8. <u>Epiglottal Trill [ʢ]</u>
9. <u>Voiceless Epiglottal Trill [ʜ]</u>
10. <u>Velopharyngeal Fricative [ʩ]</u>: In addition, the velopharyngeal fricative found in disordered speech sometimes involves trilling of the velopharyngeal port, producing a *snort*.
11. <u>Bilabial and Coronal Trill Variants</u>: The bilabial trill is uncommon. The coronal trill is most frequently alveolar [r], but dental and post-alveolar articulations [r̪] and [r̠] also occur.
12. <u>Transcription of the Retroflex Trill</u>: An alleged retroflex trill found in Toda has been transcribed [ɽ], that is, the same as a retroflex flap, but might be less ambiguously written [rɽ], as the only onset is retroflex, with the actual trill being alveolar.
13. <u>Epiglottal Trills Identified as Fricatives</u>: The epiglottal trills are identified as fricatives by the IPA, with the trilling assumed to be allophonic. However, analyzing the sounds as trills may be more economical (Esling (2010)).
14. <u>Strident Vowels accompanying Epiglottal Trills</u>: There are also so-called strident vowels which are accompanied by epiglottal trill.
15. <u>Impossible Places of Trill Articulation</u>: The cells in the IPA chart for the velar, the upper pharyngeal, and the glottal places of articulation are shaded as impossible.
16. <u>Phonation Causes the Glottis Vibrate</u>: The glottis quite readily vibrates, but this occurs as the phonation of vowels and consonants, not as a consonant of its own.
17. <u>Dorso-palatal and Velar Vibrations</u>: Dorso-palatal and velar vibratory motions of the tongue are occasionally produced, especially during the release of the dorsal stops (Ladefoged and Maddieson (1996)), and *ingressive* velar trills occur in snoring, but not in normal speech.
18. <u>Upper Pharyngeal and Epiglottal Trills</u>: The upper pharyngeal tract cannot reliably produce a trill, but the epiglottis does, and the epiglottal trills are pharyngeal in the broad sense (Esling (2010)).
19. <u>Trill Variants in Limburgish Dialects</u>: A partially devoiced pre-uvular, i.e., between velar and uvular, fricative trill [ʀ̝̥+] has been reported to occur as code allophone of /ʀ/ in the Limburgish dialects of Maastricht and Weert. It is in free variation with partially devoiced uvular fricative trill [ʀ̝̥] (Heijmans and Gussenhoven (1998), Gussenhoven and Aarts (1999)).

20. Phonemic Occurrence of Voiceless Trills: Voiceless trills occur phonemically in, e.g., Welsh and Icelandic. Mangbetu and Ninde have phonemically voiceless bilabial trills.
21. Contrastive Trills in the Czech Language: The Czech language has two contrastive alveolar trills, one of which is a fricative trill – written ř in the orthography.
22. Audible Frication during Fricative Trill: In the fricative trill the tongue is raised, so that there is audible frication during the trill, sounding a little like a simultaneous [r] and [ʐ] – or [r̥] and [ʂ] when devoiced. A symbol for this sound, [ɼ], has been dropped from the IPA, and it is now generally transcribed as a raised r [r̝].
23. Fricative/Trilled Vowels in Liangshan Yi: Liangshan Yi – "Cool Mountain" Yi – has two "buzzed" or fricative vowels /i̝/, /u̝/ - written ṳ and i̤ – which may also be trilled, [ʙ̝], [r̝].
24. Languages with trilled Affricates: A number of languages have trilled affricates, such as [mbʙ] and [dʳ].
25. Voiceless Bilabially Post-trilled Dental Stop: The Chapakuan language Wari' and the Muran language Piraha have a very unusual trilled phoneme, a voiceless bilabially post-trilled dental stop [t̪͡ʙ̥].
26. Nasal Trills of Romanian Dialects: A nasal trill [r̃] has been described from some dialects of Romanian, and is posited as an intermediate historical step in rhotacism. However, the phonetic variation of the sound in considerable, and it is not clear how frequently it is actually trilled (Sampson (1999)).

Extra-linguistic Trills

1. The Linguolabial Trill [r̼]: A linguolabial trill [r̼] is not known to be used phonemically, but occurs when blowing a raspberry.
2. Snoring, aka, Ingressive Velic Trill: Snoring typically consists of the vibration of the uvula and the soft palate/velum, which maybe described as an ingressive velic trill. Like the uvular trill, the ingressive velic trill does not involve the tongue; it is the velum that primarily vibrates in the airstream.

3. Symbol Suggested by the Speculative Grammarian: The *Speculative Grammarian* has proposed a jocular symbol for this sound – and also the sound used to imitate a pig's snort – a wide O with two dots inside, suggesting a pig's snout.
4. Velic - Alternate Term for Velopharyngeal: Velic is a term for velopharyngeal articulation between the upper surface of the velum and the back wall of the naso-pharynx (Malmberg and Kaiser (1968)).
5. Symbology used by Extended IPA: The Extensions to the IPA identifies an egressive fricative pronounced with this configuration, common with a cleft palate, as velopharyngeal [fŋ], and with accompanying uvular trill as [fŋ] – fŋ$^{\text{ʀ}}$ - or f͡ŋ.
6. Construction of the Lateral Trill: Lateral trills are also possible. They may be pronounced by imitating [ɬ] or [ɮ] with an especially forceful airflow. There is no symbol for them in the IPA.
7. Use of Lateral Coronal Trills: Lateral coronal trills are sometimes used to imitate bird calls, and are a component of Donald Duck talk.
8. Laterality of the Labiodental Trill: The labiodental trill [ʙ̪] is most likely to be lateral, but laterality is not distinctive among labial sounds.
9. Languages that use Ejective Trills: Ejective trills are not known in any language, despite being easy to produce. They may occur as mimesis of a cat's purr.

Summary

1. Attested Trilled Consonants: This excludes secondary phonations and articulations. Sounds in double parenthesis are only attested from mimesis.
2. Simple Bilabial: ʙ̥ ʙ
3. Simple Linguolabial: ((r̼̊ r̼))
4. Simple Dental: r̪̊ r̪
5. Simple Alveolar: r̥ r
6. Simple Post alveolar: r̠̊ r̠

7. <u>Simple Retroflex</u>: (ɽ̥ɽ ɽr)
8. <u>Simple Uvular</u>: ʀ̥ ʀ
9. <u>Bilabial Fricative</u>: ʙ̝
10. <u>Alveolar Fricative</u>: r̝̊ r̝
11. <u>Uvular Fricative</u>: ʀ̝̊ ʀ̝
12. <u>Simple/Fricative Pharyngeal</u>: ʜ ʢ
13. <u>Bilabial Affricate</u>: p͡ʙ̥ b͜ʙ
14. <u>Alveolar Affricate</u>: t͜r̥ d͜r
15. <u>Pharyngeal Affricate</u>: ʡ͡ʜ ʡ͡ʢ
16. <u>Alveolar Nasal</u>: r̃
17. <u>Velopharyngeal Nasal</u>: (fŋ)
18. <u>Bilabial Lateral</u>: (ʙ̺)
19. <u>Linguolabial/Dental/Alveolar/Postalveolar/Retroflex/Velar/Uvular Lateral</u>: ((bird calls))
20. <u>Bilabial/Linguolabial/Dental/Alveolar/Postalveolar/Retroflex/Velar/Uvular Ejective</u>: ((r̥'))

References

- Esling. J. (2010): Phonetic Notation, in: *The Handbook of Phonetic Sciences 2nd Edition Editors: Hardcastle, W. J., J. Laver, and F. E. Gibbon* **Wiley-Blackwell** Hoboken, NJ
- Gussenhoven, C., and F. Aarts (1998): The Dialect of Maastricht *Journal of the International Phonetic Association* **29 (2)** 155-166
- Heijmans, L., and C. Gussenhoven (1998): The Dutch Dialect of Weert *Journal of the International Phonetic Association* **28 (1-2)** 107-112
- Ladefoged, P., and I. Maddieson (1996): *The Sounds of World's Languages* **Blackwell** Oxford, UK
- Ladefoged, P., and K. Johnson (2010): *A Course in Phonetics 6th Edition* **Wadsworth Cengage Group** Boston, MA

- Malmberg, B., and L. Kaiser (1968): *Manual of Phonetics* **North Holland** Amsterdam, Netherlands
- Sampson, R. (1999): *Nasal Vowel Evolution in Romance* **Oxford University Press** Oxford, UK
- Wikipedia (2021): Trill Consonant

Phonology - Introduction

Overview

1. Alternate Meanings of the Term Phonology: *Phonology* is a branch of linguistics that studies how languages or dialects systematically organize their sounds – or signs, in sign languages. The term also refers to the sound system of any particular language variety.
2. Focus of the Phonology Field: At one time, the study of phonology only related to the study of systems of phonemes in spoken languages. Now it may relate to:
    a. Any linguistic analysis either at a level beneath the word – including syllables, onset and rime, articulatory gestures, articulatory features, mora, etc. OR
    b. All levels of language where sounds or signs are structured to convey linguistic meaning (Brentari, Fenlon, and Cormier (2018)).
3. Phonological Equivalents in Sign Languages: Sign languages have a phonological system equivalent to the system of sounds in spoken languages. The building blocks of signs are specifications for movement, location, and hand shape (Stokoe (1978)).

Terminology

1. Phonology as a Language System Component: The word *phonology* – as in *the phonology of English* – can also refer to the phonological system – the sound system – of a given language. This is one of the fundamental systems that a language is considered to comprise, like its syntax, its morphology, and its vocabulary.
2. Distinction between Phonology and Phonetics: Phonology is often distinguished from *phonetics*. While phonetics concerns the physical production, acoustic transmission, and perception of the sounds of speech (Lass (1998), Carr (2003)), phonology describes the way sounds function within a given language or across languages to encode meaning.

3. Distinction between Theoretical/Descriptive Linguistics: For many linguists, phonetics belongs to descriptive linguistics, and phonology to theoretical linguistics, although establishing a phonological system of a language is necessarily an application of theoretical principles to the application of phonetic evidence.
4. Conflation between Phonology and Phonetics: This distinction was not always made, particularly before the development of the modern concept of the phoneme in the mid-20th century.
5. Crossover of Phonology with Phonetics: Some sub-fields of modern phonology have a cross-over with phonetics in descriptive disciplines such as psycholinguistics and speech perception, resulting in specific areas such as articulatory phonology or laboratory phonology.

Derivation and Definitions

1. Origin of the Term Phonology: The word *phonology* comes from the ancient Greek φωυη, *phone, voice, sound*, and the suffix -*logy*, which is from the Greek λογος, *logos, word, speech, subject of discussion*.
2. Trubetzkoy's Definition of the Term: Trubetzkoy (1939) defines phonology as *the study of sound pertaining to the system of language*, as opposed to phonetics, which is *the study of sound pertaining to the act of speech* – the distinction between *language* and *speech* being basically Saussure's distinction between *langue* and *parole*.
3. Lass Definition of the Term: Lass (1998) writes the phonology broadly refers to the sub-discipline of linguistics concerned with the sounds of language, while in more narrow terms, *phonology proper is concerned with the function, behavior, and organization of sounds as linguistic items*.
4. Definition of Clark, Yallop, and Fletcher: According to Clark, Yallop, and Fletcher (2007), it means the systematic use of sound to encode meaning in any spoken human language, or the field of linguistics studying this use.

Analysis of Phonemes

1. Decomposed Units of Distinctive Sounds: An important part of traditional, pre-generative schools of philosophy is studying which sounds can be grouped into distinctive units within a language; these units are known as phonemes.
2. Example: Phoneme Units in English: For example, in English the *p* sound in *pot* is aspirated, while that in *spot* is not aspirated. However, English speakers treat both sounds as variations/allophones – of the same phonological category, that is of the phoneme *p*. Traditionally, it would be argued that if an aspirated *p* were interchanged with an unaspirated *p* in *spot*, native English speakers will still hear the same words; that is, the two sounds are perceived as *the same* p.
3. Phoneme Units in other Languages: In some other languages, however, these two sounds are perceived as different, as they are consequently assigned to different phonemes. For example, in Thai, Hindi, and Quechua, there are minimal pairs of words for which the aspiration is the only contrasting feature – two words can have different meanings but with the only difference in pronunciation being that one has an aspirated sound where the other has an unaspirated one.
4. Sound Inventory of Native Speakers: Part of the phonological study of language therefore involves looking at data – phonetic transcriptions of the speech of native speakers – and trying to decide what the underlying phonemes are and what the sound inventory of the language is.
5. Criteria for Identifying Minimal Pairs: The presence or absence of minimal pairs, as mentioned above, is a frequently used criteria for deciding whether two sounds should be assigned to the same phoneme. However, other considerations often need to be taken into account as well.
6. Historical Evolution of Language Phonemes: The particular contrasts which are phonemic in a language can change over time. At one time, [f] and [v], two sounds that have the same place and the manner of articulation and differ in voicing only, were allophones of the same phoneme in English, but later come to belong to separate phonemes. This is one of the main factors of historical change of languages as described in historical linguistics.

7. Interchanging the Allophones of Phonemes: The findings and insights of speech perception and articulation research complicate the traditional and somewhat intuitive idea of interchangeable allophones being perceived as the same phoneme.
8. Gibberish resulting from Allophone Switch: First, interchanged allophones of the same phoneme can result in unrecognizable words.
9. Highly Co-articulated Low-level Speech: Second, actual speech, even at a word level, is highly co-articulated, so it is problematic to be able to splice words into simple segments without affecting speech perception.
10. Assigning Sounds to Individual Phonemes: Different linguists therefore take different approaches to the problem of assigning sounds to phonemes.
11. Constraints around Allophone Sounds: For example, they differ in the extent to which they require the allophones to be phonetically similar.
12. Equivalence with the Brain Functions: There are also differing ideas as to whether this grouping of sounds is purely a tool for linguistic analysis, or reflects an actual process in the way human brain processes a language.
13. Idea behind Morphophonemes and Morphophonology: Since the early 1960s. theoretical linguistics have moved away from the traditional concept of a phoneme, preferring to consider the basic units at a more abstract level, as a component of morphemes; these units are called *morphophonemes*, and analysis using this approach is called morphophonology.

Other Topics in Phonology

1. Aspects of Phonological Studies - #1: In addition to the minimal units that can serve the purpose of differentiating meaning – the phonemes, phonology studies how sounds alternate, i.e., replace one another in different forms of the same morpheme – allomorphs, as well as, for example, syllable, stress, feature geometry, and intonation.
2. Aspects of Phonological Studies - #2: Phonology also includes such topics as phonotactics – the phonological constraints on what sounds can appear in what positions in a given language – and phonological alternation – how the pronunciation of a sound changes through the application of phonological rules, sometimes in a given order which can be feeding or

bleeding (Goldsmith (1995)), as well as prosody, the study of supra-segmentals, and topics such as stress and intonation.

3. Phonology applied to Sign Languages: The principles of phonology can be applied independently of modality because they are designed to serve as general analytical tools, not language specific ones. The same principles have been applied to analysis of the sign languages, even though the sub-lexical units are not instantiated as speech sounds (Wikipedia (2020)).

References

- Brentari, J. Fenlon, and K. Cormier (2018): *Sign Language Phonology* **Oxford Research Encyclopedia of Linguistics**
- Carr, P. (2003): *English Phonetics and Phonology: An Introduction* **Blackwell Publishing**
- Clark, J., C. Yallop, and J. Fletcher (2007): *An Introduction to Phonetics and Phonology 3rd edition* **Blackwell Publishing**
- Goldsmith, J. A. (1995): *The Handbook of Phonological Theory* **Blackwell Publishers**
- Lass, R. (1998): *Phonology: An Introduction to Basic Concepts* **Oxford University Press**
- Stokoe, W. C. (1978): *Sign Language Structure – An Outline of the Visual Communication Systems for the American Deaf* **University of Buffalo**
- Trubetzkoy, N. (1939): *Grundzuge der Phonologie* **Travaux der Cercle Linguistique de Prague 7**
- Wikipedia (2020): Phonology

Phoneme

Overview

1. Definition of a Phoneme: A *phoneme* is a unit of sound that distinguishes one word from another in a particular language (Wikipedia (2020)).

2. Meaning - Contrast through Minimal Pair: For example, in most dialects of English, with the notable exception of West Midlands and the Northwest of England (Wells (1982)), the sound patterns for *sin* and *sing* are two separate words that are distinguished by the substitution of one phoneme */n/* for another phoneme */nj/*. Two like this that differ in meaning through the contrast of a single phoneme form a *minimal pair*.

3. Phonetic Variants of a single Phoneme: If, in another language, any two sequences differ only by the pronunciation of their final sounds *[n]* and $[n_j]$ are perceived as being the same in the meaning, then these two sounds are interpreted as phonetic variants of a single phoneme in that language.

4. Notation for Representing a Phoneme: Phonemes that are established by the use of minimal pairs, such as *tap* vs *tab* or *pat* vs *bat*, are written between slashes: */p/*, */b/*. To show pronunciation, linguists use square brackets: $[p^h]$ - indicating an aspirated *p* in *pat*.

5. Analyzing a Language through its Phonemenes: There are two different views as to exactly what phonemes are and how a given language should be analyzed in *phonemic* - or *phonematic* - terms.

6. Conceptual Idea behind a Phoneme: However, a phoneme is generally regarded as an abstraction of a set - or equivalence class - of speech sounds - *phones* - that are perceived as

equivalent to each other in a given language. For example, the English *k* sounds in the words *kill* and *skill* are not identical - as described below - but they are distributional variants of a single phoneme */k/*.

7. Allophonic Variants of a Phoneme: Speech sounds that differ but do not create a meaningful change in the word are known as *allophones* of the same phoneme.

8. Factors Contributing to Allophonic Realization: Allophonic variation may be conditioned, in which case a certain phoneme is realized as a certain allophone in particular phonological environments, or it may otherwise be free, and may vary by speaker of dialect.

9. Language Phonemes versus Speech Sounds: Therefore, phonemes are often considered to constitute an abstract underlying representation for segments of words, while speech sounds makeup the corresponding phonetic realization, or the surface form.

Notation

1. Phonemes vs. Speech Sound Representation: Phonemes are conventionally placed between slashes in transcription, whereas speech sounds - phones - are placed in square brackets. Thus, */p omega integral/* represents a sequence of three phonemes, */p/*, */omega/*, */integral/* - the word *push* in Standard English, and *[p^h omega integral]* represents the phonetic sequence of sounds *[p^h]* - aspirated *p* - *[v]*, *[integral]* - the usual pronunciation of *push*.

2. Orthography Representation using Grapheme Units: This should not be confused with the similar convention of the use of angle brackets to enclose the units of orthography, graphemes. For example, *<f>* represents the written letter - grapheme - *f*.

3. IPA Based Phoneme Symbol Set: The symbols for particular phonemes are often taken from the International Phonemic Alphabet (IPA), the same set of symbols most commonly used for phones. For computer-typing purposes, systems such as X-SAMPA exist to represent IPA

symbols using only ASCII characters.

4. Custom Transcription of Language Phonemes: However, descriptions of particular languages may use different conventional symbols to represent the phonemes of those languages. For languages whose writing systems employ the phonemic principle, ordinary letters my be used to denote phonemes, although this approach is often hampered by the complicated relationship between orthography and pronunciation.

Assignment of Speech Sounds to Phonemes

1. Uniqueness of Meaning/Speech Unit: A phoneme is a sound or a group of different sounds perceived to have the same function by the speakers of the language or dialect in question.
2. Example of Phoneme in English: An example is the English phoneme */k/*, which occurs in words such as *c*at, *k*it, s*c*at, and s*k*it. Although most native speakers do not notice this, in most English dialects, the *c/k* dialects are not identical; in *kit* $[k^hit]$ the sound is aspirated, but in *skill [skil]*, it is unaspirated.
3. Similarity of the Speech Sounds: The words, therefore, contain different *speech sounds*, or *phones*, transcribed $[k^h]$ for the aspirated form and *[k]* for the unaspirated one.
4. Variations of the Phonemic Unit: These sounds are nonetheless considered to belong to the same phoneme, because if the speaker used one instead of the other, the meaning of the word would not change; using the aspirated form $[k^h]$ in *skill* might sound odd, but the word would still be recognized.
5. Phone Change Induced by Meaning Difference: By contrast, some other sounds would cause a change in meaning if substituted; for example, substitution of the sound *[t]* would produce a different word still, and that sound must therefore be considered to represent a different phoneme - the phoneme */t/*.

6. <u>Scheme for Identification of Phonemes</u>: The following simplified procedure is used for determining whether two sounds represent the same or different phonemes.

7. <u>Determining Phonemic Status of Sounds</u>:

8. <u>English Allophones *[k]* and *[k^h]*</u>: The above shows that in English *[k]* and *[k^h]* are allophones of a single phoneme */k/*.

9. <u>*[k]* and *[k^h]* as Non-phonemic</u>: In some languages, however, *[k]* and *[k^h]* are perceived as different sounds, and substituting one for another can change the meaning of the word. In those languages, therefore, the sounds represent different phonemes.

10. <u>Icelandic Language *[k]* and *[k^h]*</u>: For example, in Icelandic, *[k^h]* is the first sound of *ka'tur*, meaning cheerful, but *[k]* is the first sound of *ga'tur*, meaning *riddler*. Icelandic, therefore, has two separate phonemes */k^h/* and */k/*.

Minimal Pair

1. <u>Existence of the Minimal Pair</u>: A pair of words like *ka'tur* and *ga'tur* above that differ only in one phone is called the minimal pair for the two alternative phones in question - in this case *[k]* and *[k^h]*.

2. <u>Minimal Pair Check for Phonemes</u>: The existence of minimal pairs is a common test to decide whether two phones represent different phonemes or are allophones of the same phoneme.

3. <u>Minimal Pair Presence - English Example</u>: To take another example, the minimal pair <u>t</u>ip and <u>d</u>ip illustrate that in English, *[t]* and *[d]* belong to separate phonemes */t/* and */d/*; since both words have different meanings. English speakers must be conscious of the distinction between the two sounds.

4. Minimal Pair Absence - Korean Example: In other languages, however, including Korean, both sounds *[t]* and *[d]* occur, but no such minimal pair exists.

5. *[t]* and *[d]* as Allophones: The lack of minimal pairs distinguishing *[t]* and *[d]* in Korean provides evidence that they are allophones of a single phoneme */t/*. The word */tada/* is pronounced *[tada]*, for example.

6. Perception Variation across different Languages: That is, when they hear this word, Korean speakers perceive the same sound in both the beginning and the end of the word, but English speakers perceive different sounds in these two locations.

7. Minimal Pairs in ASL Expressions: Sign languages, such as American Sign Languages ASL also have minimal Pairs, different only in exactly one of the sign parameters: handshape, movement, location, palm orientation, and non-manual signal or marker.

8. Parameters Guiding ASL Minimal Pair: A minimal pair may exist in the sign language if the basic sign remains the same, but one of the parameters changes.

9. Phonetic Marker Dissimilarity for Phonemes: However, the absence of minimal pairs for a given pair of phones does not always mean that they belong to the sane phoneme: they may be so dissimilar phonetically that it is unlikely for speakers to perceive them as the same sound.

10. Phonetic Marker Example in English: For example, English has no minimal pair for the sounds *[h]* - as in *h*at - and *[n,]* - as in ba*ng*, and the fact that they can be shown to be in complementary distribution could be argued for their being allophones of the same phoneme. However, they are so dissimilar phonetically that they are considered separate phonemes (Wells (1982)).

11. Case of "Near Minimal Pairs": Phonologists have sometimes had to recourse to "near minimal pairs" to show that speakers of the language perceive the two sounds as significantly different even if no minimal pair exists in the lexicon.

12. Near Minimal Pair English Example: It is virtually impossible to find a minimal pair to distinguish */integral/* from */z/*, yet it seems uncontroversial to claim that the two consonants

are distinct phonemes. The two words *pleasure* and *pressure* can serve as a minimal pair (Wells (1982)).

Suprasegmental Phonemes

1. <u>Suprasegmental Phonemes Impact Word Meanings</u>: Besides segmental phonemes such as vowels and consonants, there re also suprasegmental features of pronunciation - such as tone and stress, syllable boundaries, and other forms of juncture, nasalization, and vowel harmony - which, in many languages, can change the meaning of the words and so are phonemic.
2. <u>Phonemic Stress Impacting Word Meanings</u>: *Phonemic stress* is encountered in languages such as English. For example, the word *invite* stressed on the second syllable is a verb, but when stressed on the first syllable - without changing any of the individual sounds - it becomes a noun.
3. <u>Phonemic Specification of the Word</u>: The position of the stress in the word affects the meaning, so a full phonemic specification - providing enough detail to enable the word to be pronounced unambiguously - would include indication of the position of the stress: */inv'ait/* for the verb, */'invait/* for the noun.
4. <u>Languages where Stress is Non-phonemic</u>: In other languages, such as French, word stress cannot have this function - its position is generally predictable - and is therefore not phonemic, and is not usually indicated in dictionaries.
5. <u>Phonemic Tones Impacting Word Meanings</u>: *Phonemic tones* are found in languages such as Mandarin Chinese, in which a given syllable can have 5 different tonal pronunciations.
6. <u>Phonetic Variants of the Word *Ma*</u>:
7. <u>Meanings Induced by Tonal Variations</u>: Here, the character pronounced *mā* - high level pitch - means *mother*; *ma'*, rising pitch, means *hemp*; *mau*, falling then rising, means *horse*; *ma*`,

falling, means *scold*; and *ma*, neutral tone, is an interrogative particle. The tone phonemes in such languages are called *tonemes*.

8. Phonemic Intonation Impacting Word Meanings: Languages such as English do not have phonemic tones, although they use intonation for functions such as emphasis and attitude.

Distribution of Allophones

1. Complementary Distribution of Allophones: When a phoneme has more than one allophone, the only actually heard at the given occurrence of that phoneme may be dependent on the phonetic environment, i.e., surrounding sounds; allophones which normally cannot appear in the same environment are said to be in the complementary distribution.
2. Free Variation in the Allophones: In other cases, the choice of the allophone may be dependent on the individual speaker or other unpredictable factors - such allophones are said to be in free variation, but allophones are still selected in a specific phonetic context, not the other way around.

Background and Related Ideas

1. Meaning of the Greek Word: The term *phoneme* - from the ancient Greek *pho-ne-ma* - "sound made, utterance, thing spoken, speech, language" (Liddell and Scott (1940)) - was reportedly used first by Dufriche-Desgenettes in 1873, but it referred only to a speech sound.
2. Fonema - Basic Unit of Psychophonetics: The term *phoneme* as an abstraction was developed by the Polish linguist Jan Niecislaw Baudouin de Courtenay and his student Nikolaj

Kruszewski during 1875-1895 (Jones (1957)). The term used by these two was *fonema*, the basic unit of what they called *psychophonetics*.

3. Modern Usage of the Word Phoneme: Jones (1919) became the first linguist in the Western world to use the word *phoneme* in the current sense.

4. Elaboration of the Phoneme Concept: The concept of the phoneme was then elaborated in the works of Nikolai Trubetzkoy and others of the Prague during the years 1926-1935, and in those of the structuralists like Ferdinand de Saussure, Edward Sapir, and Leonard Bloomfield.

5. Psycholinguistic Role for Phonemes: Some structuralists - though not Sapir - rejected the idea of a cognitive or psycholinguistic function for the phoneme (Twaddell (1935), Harris (1951)).

6. Deprecation/Enhancement of the Phoneme Concept: Later, it was used and redefined in generative linguistics, most famously by Chomsky and Halle (1968), and remains central to many accounts of the development of modern phonology. As a theoretical concept or model, however, it has been supplemented and even replaced by others (Clark and Yallop (1995)).

7. Decomposition of Phonemes into Features: Some linguists - such as Jakobson and Halle (1968) - proposed may be further decomposed into features, such features being the minimal constituents of language.

8. Evolution of Sub-phonemic Features: Features overlap each other in time, as do suprasegmental phonemes in oral languages and many phonemes in sign languages.

9. Schemes for Extracting the Features: Features can be characterized in different ways: Jakobson, Fant, and Halle (1952) described them in acoustic terms, Chomsky and Halle used a predominantly articulatory basis, though retaining some acoustic features, while Ladefoged's system (Ladefoged (2006)) is purely an articulatory system apart from the use of the acoustic term 'sibilant'.

10. Duration Chronemes and Tone Phonemes: In the description of some languages, the term *chroneme* has been used to indicate the contrastive length or *duration* of phonemes. In

languages in which tonemes are phonemic, the tone phonemes may be called tonemes.

11. <u>Widespread Acceptance of the Above Terms</u>: Though not all scholars working on such languages use these terms, they are by no means obsolete.

12. <u>Other Fundamental Units in Linguistics</u>: By analogy with the phoneme, linguists have proposed other sorts of underlying objects, giving them names with the suffix *-eme*, such as *morpheme* and *grapheme*. These are sometimes called emic units.

13. <u>Generalization of Emics and Etics</u>: The latter term was first used by Pike (1967), who generalized the concepts of emic and etic descriptions - from *phonemic* and *phonetic* respectively - to applications outside linguistics.

Restrictions on Occurrence

1. <u>Phonotactic Combinations Constraints - Restricted Phonemes</u>: Languages do not allow generally words or syllables to be built of any arbitrary sequence of phonemes; there are phonotactic restrictions on which sequences are possible and in which environments certain phonemes can occur. Phonemes that are significantly limited by such restrictions may be called *restricted phonemes*.

2. <u>Phonemic Restrictions in English #1</u>: In English, examples of such restrictions include: /n_j/, as in *si**ng***, occurs only at the end of a syllable, never at the beginning - in many other languages, such as Maori, Swahili, Tagalog, and Thai, /n_j/ can appear word-initially.

3. <u>Phonemic Restrictions in English #2</u>: /h/ occurs only before vowels and at the beginning of a syllable, never at the end - a few languages, such as Arabic or Romanian, allow /h/ syllable-finally.

4. <u>Phonemic Restrictions in English #3</u>: In non-rhotic dialects, /inverse_r/ can only occur before a vowel, never before a consonant.

5. Phonemic Restrictions in English #4: /w/ or /j/ occur only before a vowel, never at the end of a syllable - except in interpretations where a word like *boy* is analyzed as /b mirrored_c j/.

6. Analysis using Neutralization and Archiphonemes: Some phonotactic restrictions can alternatively be analyzed as cases of neutralization. In the below section on Neutralization and archiphonemes, a particular example of the occurrence of the three English nasals before stops is shown.

Biuniqueness

1. Meaning of the Biuniqueness Requirement: Biuniqueness is a requirement of the classical structuralist phonemics. It means that a given phone, wherever it occurs, must be unambiguously assigned to one and only one phoneme. In other words, the mapping between phones and phonemes is required to be many-ti-one rather than many-to-many.

2. Controversial Nature of the Postulate: The notion of biuniqueness was controversial among some pre-generative linguists and was prominently challenged by Halle and Chomsky in the late 1950s and early 1960s.

3. Alveolar Flaps as a Counter-point: An example of the problems arising frm the biuniqueness requirement is provided by the phenomenon of flapping in North American English. This may cause either /t/ or /d/ - in the appropriate environments - to be realized with the phone [snipped r] - an alveolar flap.

4. Non-contrastive Phonemes - Contextual Realization: For example, the same flap sound may be heard in the words *hi**tt**ing* and *bi**dd**ing*, although it is intended to realize the phoneme /t/ in the first word and /d/ in the second. This appears to contradict biuniqueness. The next section has a detailed discussion of such cases.

Neutralization an Archiphonemes

1. Neutralization of the Phonemic Contrast: Phonemes that are contrastive in certain environments may not be contrastive in all environments. In environments where they do not contrast, the contrast is said to be *neutralized*. In these positions, it may become less which phoneme a given phone represents.

2. Non-realized Phonemes - Absolute Neutralization: *Absolute Neutralization* is a phenomenon in which a segment of the underlying realization is not realized in any of phonetic representations.

3. Non-contrastive Phonemes - Contextual Realization: The term was introduced by Kiparsky (1968), and contrasts with *contextual neutralization* where some phonemes are not contrastive in certain environments.

4. Representation using Under-specification - Archiphoneme: Some phonologists prefer not to specify a unique phoneme in such cases, since to do so would mean providing redundant or even arbitrary information - instead they use the technique of under-specification. An *archiphoneme* is an object sometimes used to represent an under-specified phoneme.

5. Example: Stressed/Unstressed Contrastive Realizations: An example of neutralization is provided by the Russian vowels /a/ and /o/. These phonemes are contrasting in stressed syllables, but in unstressed syllables the contrast is lost, since both are reduced to the same sound - usually [flipped_e] - owing to vowel reduction in Russian.

6. Factors Impacting the Phonemic Assignment: In order to assign such an instance of [flipped_e] to one of the phonemes /a/ and /o/, it is necessary to consider morphological factors, such as the vowels that occur in other forms of the words, or which inflectional pattern is followed. In some cases, this may not even provide an unambiguous answer.

7. Using Under-specification for Description: A description using the approach of under-specification would not attempt to assign [flipped_e] to a specific phoneme in some or all of

the cases, although it may be assigned to an archiphoneme, written something like //A//, which reflects two neutralized phonemes in this position.

8. English Example - Contrasting Nasal Phonemes: A somewhat different example is found in English, with the three nasal phonemes /m, n, n_j/. In word-final position, all these contrast, as shown by the minimal triplet *sum* /s^m/, *sun* /s^n/, *sung* /s^n_j/.

9. Exclusiveness of Nasals Preceding Stops: However, before a stop such as /p, t, k/ - provided there is no morpheme boundary between them - only one of the nasals is possible in any given position: /m/ before /p/, /n/ before /t/ or /d/, and /n_j/ before /k/, as in *limp*, *link*, *link*, - /limp/, /lint/, /lin_jk/.

10. Non-contrastive Nature of these Phonemes: The nasals are therefore not contrastive in these environments, and according to some theorists this makes it inappropriate to assign the nasal phones heard here to any of the phonemes - even though, in this case, the phonetic evidence is unambiguous.

11. Archiphonemic Representation of these Nasals: Instead, they may analyze these phones as belonging to a single archiphoneme, written something like //N//, and state the underlying representations of *limp*, *link*, *link* to be //liNp//, //liNt//, //liNk//.

12. Alternate Notation for Representing Archiphonemes: This latter type of analysis is often associated with Nikolai Trubetzkoy of the Prague School. Archiphonemes are often notated with a capital letter within double virgules or pipes, as with examples //A// and //N// given above. Other ways the second of these has been notated include |m-n-n_j|, {m, n, n_j}, and //n*//.

13. English Example - Alveolar Flap Phonemes: Another example from English, but this time involving complete phonetic convergence as in the Russian example, is the flapping of /t/ and /d/ in some accents of American English - described above under Biuniqueness.

14. Phonemes Implied by Consistent Flapping: Here the word *betting* and *bedding* may ne pronounced ['b epsilon snipped_r i n_j]. Under the generative grammar theory of linguistics, if a speaker applies such flapping consistently, morphological evidence - the pronunciation of the related forms *bet* and *bed*, for example - would reveal which phoneme the flap represents,

once it is known which morpheme is being used (Dinnsen (1985)).

15. Archiphoneme Approach to Flap Determination: However, other theorists would prefer not to make such a determination, and simply asign the flap in both cases to a single archiphoneme, written - for example - //D??.

16. English Example - Plosives Succeeding /s/: Further mergers in English are plosives after /s/, where /p, t, k/ conflate with /b, d, g/, as suggested by the alternative spellings *sketti* and *sghetti*. That is, there is no particular reason to transcribe *spin* as /'spin/ rather than as /'sbin/, other than its historical development, and it may be less ambiguously transcribed as //'sBin//.

Morphemes

1. Sub-division into Morphophonemes and Morphemes: A *morphophoneme* is a theoretical unit at a deeper level of abstraction than traditional phonemes, and it taken to be a unit from which morphemes are built up.

2. Dividing Allomorphs to Uncover Morphophonemes: A morphophoneme within a morpheme can be expressed in different ways in different allomorphs of that morpheme - according to morphophonological rules.

3. Morphophonemic Representation of English Plurals: For example, the English plural morpheme -*s* appearing in words such as *cats* and *dogs* can be considered to be a single morphophoneme, which might be transcribed - for example - //z// or |z|, and which is realized as phonemically |s| after most voiceless consonants - as in *ca**ts*** - and as |z| in other cases - as in *dog**s***.

Number of Phonemes in Different Languages

1. Phones Produced by Natural Languages: All known languages use only a small subset of the many possible sounds that the human speech organs can produce, and, because of allophones, the number of distinct phonemes will generally be smaller than the number of identifiably different sounds.
2. Phonemic Inventory Range across Languages: Different languages vary considerably in the number of phonemes that have in their systems, although apparent variation might sometime result from the different approaches taken by the linguists doing the analysis. The total phonemic inventory in languages varies from as few as 11 in Rotokas and Piraha to as many as 141 in !Xu~ (Crystal (2010)).
3. Lowest Count of Vowel Phonemes: The number of phonemically distinct vowels can be as low as 2, as in Ubuyk and Arrernte.
4. Highest Count of Vowel Phonemes: At the other extreme, the Bantu language Ngwe has 14 vowel qualities, 12 of which may occur long or short, making 26 oral vowels, plus 6 nasalized vowels, long and short, making a total of 38 vowels; while !Xo'o~ achieves 31 pure vowels, not counting the additional variation by vowel length, by varying the phonation.
5. Lowest Count of Consonant Phonemes: As regards consonant phonemes, Puinavae and the Papuan language Tauade each have just 7, and Rotokas has only 6.
6. Highest Count of Consonant Phonemes: !Xo'o~, on the other hand, has somewhere around 77, and Ubykh 81.
7. Vowel Phoneme Range in English: The English language uses a rather large set of 13-21 vowel phonemes, including diphthongs, although its 22-26 consonants are close to average.
8. Phonemes due to Tones/Stress: Some languages, such as French, have no phonemic tone or stress; while Cantonese and several other Kim-Sui languages have 9 tones, and one of the Kui languages, Wobe', has been claimed to have 14 (Bearth and Link (1980)), though this is disputed (Singler (1984)).

9. Common Vowel/Consonant Phoneme Set: The most common vowel system consists of 5 vowels /i/, /e/, /a/, /o/, /u/. The most common consonants are /p/, /t/, /k/, /m/, /n/ (Moran, McCloy, and Wright (2014)).
10. Languages that lack Common Consonants: Relatively few languages lack any of these consonants, although it does happen: for example, Arabic lacks /p/, standard Hawaiian lacks /t/, Mohawk and Tlingit lack /p/ and /m/, Hupa lacks both /p/ and a simple /k/, colloquial Samoan lacks /t/ and /n/, while Rotokas and Quileate lack /m/ and /n/.

The Non-Uniqueness of Phonemic Solutions

1. Uniqueness of the Phonemic Construct: During the development of the phoneme theory in the mid-20th century phonologists were concerned not only with the procedures and the principles involved in producing a phonemic analysis of the sounds in a given language, but also with reality or uniqueness of the phonemic solution.
2. Pike's Statement on Phonemic Uniqueness: Some writers took the position expressed by Pike (1947): "There is only one accurate phonemic analysis of a given set of data", while others believed that different analysis, equally valid, could be made for the same data.
3. Chao's Statement on Phonemic Uniqueness: Chao (1934) stated: "Given the sounds of a language, there are usually more than one possible way of reducing them to a set of phonemes, and those different systems or solutions are not simply correct or incorrect, but may be regarded as only being good or bad for various purposes".
4. Analysis Using English Vocal System: Householder (1952) referred to this debate within linguistics as "God's truth vs. hocus-pocus". Different analysis of the English vowel system may be used to illustrate this.
5. Wikipedia on English Vowel Phonemes: The article on English phonology (Wikipedia

(2021)) states that English has a particularly large number of vwel phonemes, and that there are 20 vowel phonemes in Received Pronunciation, 14-16 in General American, and 20-21 in Australian English; the previous section indicated that the English language uses a rather large set of 13-21 vowel phonemes.

6. Alternate Transcription of English Phonemes: Although these figures are often quoted as a scientific fact, they actually reflect only one of many possible analysis, and Wikipedia (2021) suggests an alternate analysis in which some diphthongs and long vowels may be interpreted as comprising a short vowel linked to either /j/ or /w/.

7. Vowel Phonemes for RP: The transcription system for British English (RP) devised by Lindsay in 2017 and used in the CUBE pronunciation dictionary also treats diphthongs as composed of a vowel plus /j/ or /w/.

8. Exposition of Trager and Smith: The fullest exposition of this approach is found in Trager and Smith (1951) where all long vowels and diphthongs - "complex nuclei" - are made up of a short vowel combined with either /j/, /w/, or /h/ - plus /r/ for rhotic accents, each thus comprising two phonemes. They write: "The conclusion is inescapable that complex nuclei consist each of two phonemes, one of the short vowels followed by one of the 3 glides".

9. Alternate Transcriptions for the Words: The transcription for the vowel normally transcribed /ai/ would be instead /aj/, /a v with horns/ would be /aw/, and /a:/ would be /ah/.

10. Significantly Reduced Count of Vowels: The consequence of this approach is that English could theoretically have only 7 vowel phonemes, which is symbolized /i/, /e/, /a/, /o/, /u/, /^/, and /flipped-e/, or even 6 if schwa were treated as an allophone of /^/ or of other short vowels, a figure that would put English much closer to the average number of vowel phonemes in other languages.

11. Competing Basis for Phonemic Analysis: In the same period there was disagreement about the correct basis for phonemic analysis.

12. Analysis Using only Sound Elements: The structuralist position was that the analysis should be made purely on the basis of the sound elements and their distribution, with no reference to extraneous factors such as grammar, morphology, or the intuitions of native speakers; this

position is associated with Bloomfield (1933).

13. Analysis Using Phonetic Segment Distribution: Harris (1951) claimed that it is possible to discover phonemes of a language purely by examining the distribution of phonetic segments.

14. Twaddell's Statement on Mentalistic Approaches: Referring to the mentalistic definitions of a phoneme, Twaddell (1935) states: "Such a definition is invalid because a) we have no right to guess about the linguistic workings of an inaccessible 'mind', and b) we can secure no advantage from such guesses. The linguistic processes of the 'mind' are as such quite simply unobservable, and introspection about linguistic processes is notoriously a fire in the wooden stove".

15. Value Attributed to Native Speaker's Intuition: Using English [n_j] as an example, Sapir (1925) argued that, despite the superficial appearance that this belongs to a group of nasal consonants, "no native English speaking person can be made to feel in his bones that it belongs to a single series with /m/ and /n/ ... It still feels like n,g".

16. Emergence of Mentalist over Structuralist: The theory of generative phonology which emerged in the 1960's explicitly rejected the Structuralist approach to phonology and favored the mentalistic or cognitive view of Sapir (Chomsky (1964), Chomsky and Halle (1968)).

Correspondence Between Letters and Phonemes

1. Equivalence of Phonemes to Graphemes: Phonemes are considered to be the basis for alphabetic writing systems. In such systems, the written symbols - graphemes - represent, in principle, the phonemes of the language being written.

2. Alphabet System for Classical Latin: This is most obviously the case when the alphabet was invented with a particular language in mind; for example, the Latin alphabet was designed for Classical Latin, and therefore the Latin of that period enjoyed a near one-to-one

correspondence between phonemes and graphemes in most cases, though the devisers of the alphabet chose not to represent the phonemic effect of vowel length.

3. Established Orthography vs. Evolving Phonemes: However, because changes in spoken language are not often accompanied by changes in established orthography - as well as other reasons, including dialect differences, the effects of morphophonology on orthography, and the use of foreign spellings for some loanwords - the correspondence between spelling and pronunciation in a given language may be highly distorted; this is the case with English, for example.
4. Correspondence between Phonemes and their Symbols: The correspondence between symbols and phonemes in alphabetic writing systems is not necessarily a one-to-one correspondence.
5. Phonemes Constructed using Letter Combinations: A phoneme might be represented by a combination of 2 or more letters - digraph, trigraph, etc., like <sh> in English or <sch> in German, both representing phoneme /integral/.
6. Single Symbol Representing Multiple Phonemes: Also, a single symbol may represent two phonemes, as in English <x> representing |gz| or /ks/.
7. Complications arising from Pronunciation Rules: There may also exist spelling/pronunciation rules - such as those for the pronunciation of <c> in Italian - that further complicate the correspondence of letters to phonemes, although they need not affect the ability to predict the pronunciation from spelling and vice versa, provided the rules are known.

In Sign Languages

1. Sign Language Articulation Feature Bundles: Sign language phonemes are bundles of articulation features. Stokoe was the first scholar to describe the phonemic system of ASL.

2. Identifiers from Tab/Dez/Sig: He identifies the bundles *tab* - elements of location, from Latin *tabula*, *dez* - the handshape, from *designator*, *sig* - the motion, from *signation.* Some researchers also discern *ori* - orientation, facial expression, or mouthing.

3. Sign Phonemes and Minimal Pairs: Just as with spoken languages, when features are combined, they create phonemes. As in spoken languages, sign languages have minimal pairs which differ in only one phoneme.

4. Examples - Father/Mother ASL Signs: For instance, the ASL signs for *father* - https://media.spreadthesign.com/video/mp4/13/455635.mp4 - and *mother* - https://media.spreadthesign.com/vides/mp4/13/48601.mp4 - differ minimally with respect to location while handshape and movement are identical; location is thus contrastive.

5. Limitations of Stokoe's terminology/Notation: Stokoe's terminology and notation system are no longer used by researchers to describe the phonemes of sign language; Stokoe's research, while still considered seminal, has been found to not characterize American Sign Language of other sign languages sufficiently (Clayton and Lucas (2000)).

6. Enhancement to Sign Language Phonology: For instance, non-manual features are not included in Stokoe's classification. More sophisticated models of sign language phonology have since been proposed by Sandler (1989), Brentari (1998), and van der Kooij (2002).

Chereme

1. The Basic Unit of Sign: *Cherology* and *chereme* - from Ancient Greek *chi epsilon i rho* "hand" - are synonyms of phonology and phoneme previously used in sign languages. A *chereme,* as the basic unit of signed communication, is functionally and psychologically equivalent to the phonemes of oral languages, and has been replaced by that term in the academic literature.

2. Cherology - Study of Sign Cheremes: *Cherology*, and the study of *cheremes* in language, is thus equivalent to phonology. The terms, are, not in use anymore. Instead, the terms *phonology* and *phoneme* - or *distinctive feature* - are used to stress the linguistic similarities between signed and spoken languages (Bross (2015)).
3. Acceptance of the above Terminology: The terms were coined by Stokoe (1960) at Gallaudet University to describe sign languages as true and full languages. Once a controversial idea, the position is now universally accepted in linguistics. Stokoe's terminology, however, has been largely abandoned.

References

- Bearth, T., and C. Link (1980): The Tone Puzzle of Wobe *Studies in African Linguistics* **11 (2)** 147-207
- Bloomfield, L. (1933): *Language* **Henry Holt**
- Brentari, D. (1998): *A Prosodic Model of Sign Language Phonology* **MIT Press**
- Bross, F. (2015): Chereme, in: *Dictionaries of Linguistics and Communication Science, T. A. Hall and B. Pompino-Marschall editors* **Mouton de Gruyter**
- Chao, Y. R. (1934): The non-uniqueness of Phonemic Solutions of Phonetic Systems *Academia Sinica* **4 (4)** 363-397
- Chomsky, N. (1964): *Current Issues in Linguistic Theory* **Mouton**
- Chomsky, N. and M. Halle (1968): *The Sound Pattern of English* **Harper and Row**
- Clark, J., and C. Yallop (1995): *An Introduction to Phonetics and Phonology, 2nd Edition* **Blackwell**

- Clayton, V., and C. Lucas (2000): *Linguistics of the American Sign Language - An Introduction 3rd Edition* **Gallaudet University Press** Washington D.C.
- Crystal, D. (2010): *The Cambridge Encyclopedia of Language 3rd Edition* **Cambridge** UK
- Dinnsen, D. (1985): A Re-examination of Phonological Neutralization *Journal of Linguistics* **21 (2)** 265-279
- Harris, Z. (1951): *Methods in Structural Linguistics* **Chicago University Press**
- Householder, F. W. (1952): Review of Methds in Structural Linguistics by Zellig W. Harris *International Journal of American Linguistics* **18** 260-268
- Jakobson, R, G. Fant, and M. Halle (1952): *Preliminaries to Speech Analysis* **MIT**
- Jakobson, R., and M. Halle (1968): Phonology in Relation to Phonetics, in *Manual of Phonetics, editor: B. Malmberg* **North-Holland**
- Jones, D. (1919): The Phonetic Structure of the Sechuana Language *Transactions of the Philological Society* **28 (1)** 99-106
- Jones, D. (1957): The History and the Meaning of the Term Phoneme *Le Maitre Phonetique* **35 (72)** 1-20
- Kiparsky, P. (1968): Linguistic Universals and Linguistic Change, in: *Universals in Linguistic Theory (E. Bach and R. T. Harms - editors)* **Holt, Rinehart, and Winston** New York
- Ladefoged, P. (2006): *A Course in Phonetics 5th Edition* **Thomson**
- Liddell, H. G., and R. Scott (1940): *A Greek-English Lexicon* **Clarendon Press** Oxford
- Moran, S., D. McCloy, and R. Wright (2014): *PHOIBLE Online* **Max Planck Institute for Revolutionary Anthropology** Leipzig, Germany
- Pike, K. L. (1947): *Phonemics* **University of Michigan**
- Pike, K. L. (1967): *Language in Relation to a Unified Theory of Human Behavior* **Mouton**

- Sandler, W. (1989): *Phonological Representation of the Sign: Linearity and Nonlinearity in American Sign Language* **Fortis**
- Sapir, E. (1925): Sound Patterns in Language *Language* **1 (37)** 37-51
- Singler, J. V. (1984): On the Underlying Representation of Contour Tones in Wobe *Studies in African Linguistics* **15 (1)** 59-75
- Stokoe, W. C. (1960): *Sign Language Structure: An Outline of the Visual Communication Systems of the American Deaf* **University of Buffalo**
- Trager, G. and H. Smith (1951): *An Outline of English Structure* **American Council of Learned Societies**
- Twaddell, R. F. (1935): *On Defining the Phoneme* **Linguistic Society of America**
- van der Kooij, E. (2002): *Phonological Categories in the Sign Language of the Netherlands - the Role of Phonetic Implementation and Iconicity* **Leiden University**
- Wells, J. (1982): *Accents of English* **Cambridge University Press**
- Wikipedia (2020): Phoneme (https://en.wikipedia.org/wiki/Phoneme)
- Wikipedia (2021): English Phonology (https://en.wikipedia.org/wiki/English_phonology)