# SIGNIFICANCE OF OPTIMALITY THEORY IN PHONOLOGICAL ACQUISITION AND IN ASSESSMENT AND INTERVENTION OF PHONOLOGICAL DISORDERS

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# Contents

CHAPTER – 1

# Introduction

## 1.1. Speech and Language

### 1.1.1. *Speech and Language: Communicative Aspect*

To satisfy their physical and emotional needs, humans have to communicate and convey the message to other human. Communication can be either in verbal or non-verbal mode. Human is the one who has an access to a unique mode of communication called language. Human communication involves the affluent sewing of pieces of information conveyed through movements, emotional expression, and vocalizations. As for verbal communication, people have the innate capability to access language. Verbal communication starts with the development of speech during the infancy period and later with language development, getting complete by five to six years. Apart from verbal communication, non-verbal communication is also used to express one's needs. Non-verbal communication is employed in gestures, sign language, and body language. However, people mainly depend on the verbal mode of communication to convey their needs and ideas in a better way. Verbal communication represents ideas and thoughts more clearly than non-verbal communication. So, speech is one form of communication that enables humans to convey information with specific details.

Thus, man's primary and most preferable method of communication is speech. Speech production is a human activity that is highly complex and variable. The variation is fundamentally due to the execution pattern and the intention behind the speech act. Speech is a system that frequently and conveniently shares the meaning of an utterance with the sounds through which the language is spoken (Atkinson, McWhinney, and Stoel 1968). On the other hand, language covers complicated rules that bind sounds, words, sentences, meaning, and use. These rules motivate an individual's ability to comprehend, plan, and produce the language. The language process happens receptively and expressively through reading, listening, writing, and speaking. To become a functioning member of society, a child must learn this system's elements, rules, structures, and conventions; effective verbal communication seems necessary to belong in society. So, language as a system consists of five levels: phonology, morphology, syntax, semantics, and pragmatics (Nancy, Parley & Wayne, 1989), which are to be mastered for efficient and effective communication. Children's speech and language skills develop according to clear milestones in the above levels. A child's language development starts with phones and phonemes. Then, by nine months to one and a half years, the child utters sensible and, to some extent, intelligible words, which are the stepping stones of language production. From one and a half years to two years, children's language development is seen in the form of two-word utterances (as phrases). Three and four-word phrases are formed in three to five years, and simple, compound, and complex sentences emerge at this stage. Amidst all these developmental stages, the acquisition and developmental stage of phones and phonemes are very crucial (Templin, 1957; Piaget, 1952; and Ingram, 1976) as they play a vital role in the intelligibility of speech that happens up till one and a half years or two years.

## Acquisition of speech sound production

The patterns of acquisition of phonology in children (Templin, 1957) are as follows:

- In the early years of childhood, diphthongs, vowels, consonants, double consonant blends, and triple consonant blends are produced in the most to least accurate order.

- The consonants are produced in the following order: nasals, plosives, fricative, and semi-vowels.
- The voiceless consonant elements are produced more accurately than the voiced ones.
- By eight years, all children produce all the sounds correctly.

On the other hand, Ingram (1976) has identified six stages of phonological development. He relates these steps to Piaget's (1962) stages of cognitive development. These steps are outlined below:

1. **Piaget's period of sensorimotor development:** Ingram identified two stages of phonological acquisition during this period
    - Birth to 12 months: The child communicates through crying and gestures. Particular prerequisites for speech are also developed, like speech perception, babbling, and imitation.
    - 12 to 18 months: The child develops a vocabulary of around 50 words.
2. **Piaget's period of concrete operations:** The cognitive period lasts from 18 months to 12 years. The first sub-stage, pre-conceptual thought, coincides with the next stage of phonological development.
    - 18 months to four years: The child acquires most of the sounds of the language and learns to combine them into simple words.
    - four to seven years: The child completes phonetic inventory and begins using complex words.
    - seven to 12 years: The child refines his knowledge of the morphophonemic rules of language (tense markers, plurals, derivational rules, nouns, verbs, and adjectives). He indicates that development during this period may be related to learning to read.
3. **Period of formal operations:**
    - 12 to 16 years: The advanced development of metalinguistic understanding allows the child to make

conscious judgments about the phonological system (i.e., meta-phonological awareness). He states that this ability may be necessary for learning to spell.

So, phonology patterns start from the birth cry and grow with speech and language development until age 5 to 6.

### 1.1.2. Speech and Language Development

The language development from zero to two years was studied by many Western and Indian scholars who account for the cooing, babbling, and holophrastic stages during this period. Infants first begin vocalizing by crying, followed by cooing and then vocal play.

#### a. Birth cry

A birth cry is produced by a complex biological phenomenon that combines neural and physiological mechanisms. Some Western studies (Corwin, M. J. et al. 1987, 1995, Sirviö P. et al. 1976, and Rothgänger, H. 2003) on birth cry specify that the birth cry may signal language developmental milestones. Some researchers suppose that these pre-speech vocalizations/cries are reflexes that provide practice for motor activities. However, many child language researchers believe they are directly related to language development. The research is done on children with Autism (Esposito, G. et al. 2014); children with Down's syndrome (Fisichelli, V.R. et al. 1966); children with Cri-du-chat syndrome (Vuorenkoski, V. 1966); children with cleft palate (Wermke, K. et al. 2001); and children with brain damage (Karelitz, S. 1962) show their connections between abnormal cries and disorders which suggest a differential diagnosis of specific pathologies.

#### b. One month – crying and smiling

Crying is not considered conversational, but it is the newborn's primary way of communication. Using this, a child indicates that she/he is "tired", "in need of food", "in pain" and "uncomfortable".

Crying also leads the baby to natural language by strengthening the same neural pathways in the brain used for speech and giving her larynx, the organ in the throat responsible for sound production, which is an exercise for the baby's vocal cords. There is research (Corwin, M. J. et al. 1987; Sirviö P. et al. 1976; Rothgänger, H. 2003; Esposito, G. et al. 2014; Fisichelli, V. R. et al. 1966; Vuorenkoski, V. 1966; Wermke, K. et al. 2011; and Karelitz, S. 1962) that has studied the pitch and intensity patterns of crying of both typically developing children and children with some disorders, indicating that specific patterns are universal in crying by typically developing group than that of children with disorders.

**c. Two to five months – cooing and chortling**

At this stage, infants cry differently in different situations and coo in response to the speaker with glottal plosives. Those super cute coos are airy sounds that come straight from the larynx, making them easy to say for infants still figuring out how to use their lips and tongues. Infants at this stage tend to focus on particular sounds, squeals, vowels, or growls when we speak to them or call them. Research shows that the high pitch makes the infants notice and want to imitate what the speaker says. These practices will help the infant learn to control vocal tone and volume, something the child needs to form his/her first word.

**d. Six to eight months – babbling**

When infants begin to add in consonants, it means she/he now able to produce a full repertoire of sounds, which is a major linguistic milestone: "It is harder to generate consonants because they require interaction between the tongue and the lips" (Golinkoff, R. M. et al. 2001). Golinkoff, R. M. et al. (1999, 2000, and 2001) have found that infants understand far more than we realize. This stage is called the babbling stage, where repetitive CV patterns occur. The infants babble in distinct syllables at this stage, as their "conversation" can sound so much like language that it is hard to tell.

This is the period when children connect objects with words while the adults speak about the things around them. So: "Just do not assume "ka-ka" means "car" if a child says it while reaching for his/her toy. One has to notice where the child is looking before labeling an object. It is very adaptive for babies, and many parents do it naturally" (Romberg A.R., Saffran J.R. 2010, Hay J.F., Pelucchi B., Graf Estes K., Saffran J.R. 2011). Babbling is often connected with phonological development as it is a developmental stage of consonants. Most authors agree that the babbling at this stage is already closely related to the first words. Children at this stage produce sounds in one breath; babble with some CV syllables ("bababa"); use */m/ ,/p/, /b/, /n/, /t/, /d/* in babbling; enjoy imitating sound sequences; imitates sounds, cough, tongue clicking (increased tongue tip activity), etc. They even have some onomatopoeia in this babbling, and their babbling shows pitch and inflectional changes. They copy (sometimes inaccurately) intonation contours and start to develop certain vowels, syllables, and diphthongs). So, their babbling patterns at this stage have various forms.

**Forms of babbling:**

i. ***Reduplicated babbling/ canonical babbling***
At this stage, a similar string of consonant-vowel production occurs. That is, syllables are reduplicated. There might be slight quality variations in the vowel sounds of these strings of babbles, according to Elbers (1982), Oller (1988), and Strak (1979); however, the consonants will stay the same from syllable to syllable. For example, papə…, bɑbʌ…, and even longer chains, like dɑdɑdɑdɑ…etc. However, Mitchell and Kent (1990), in their study, have questioned the above-said variation in vowels, saying that changes in vowels happen only in variegated babbling. Canonical babbling is syllabic, containing mainly frontal stops, nasals, and glides coupled with lax vowels \a\, \o\, and \e\. The emergence of canonical babbling is highly significant, holding predictive value for future linguistic developments.

ii. ***Non-reduplicated babbling or variegated babbling***
At this stage, consonants and vowels may vary from syllable to syllable. For example., pamə…, mɑbʌ…, tɑgʌ…etc. and sequences of different consonants and vowels (e.g., CV, V, VC, VCV = \ta\pi\ma\ida\). These productions are not real words, as they do not have any meaning.

According to Oller et al. (1988), children who do not produce canonical babbling at the right period are at high risk for future speech and language issues and should be carefully evaluated by a language clinician.

### e. Nine to 18 months – jargon and holophrastic stage

Children's babbling will gradually resemble adult speech, even though they may not be using "real" words yet. Their babbling will start to take on the tones and infections of adult speech, even though the "words" still resemble babble. We refer to this as jargon. According to the jargon or intonated babble, infants produce long syllables with different stress and intonation patterns. Jargon begins by the eighth month and often continues until the second year. Jargon sounds like whole sentences conveying the contents of statements or questions and often co-occurs with actual words. The child slowly replaces the jargon with actual words, phrases, and sentences over the second year of life. However, their speech is short of linguistic content or grammatical structure.

Also, the stage at which the child produces single words for complex ideasand simple fixed expressions is called a holophrastic stage. For example, the word "daddy" might be used to mean "daddy beat me" and the word "down" to convey "leave me down." During this period of real word production, the children's phonological system might not have been fully developed, and they will produce words with substitution, reduction, and assimilation of the phonemes in that word.

### f. 18 to 36 months – telegraphic speech

Telegraphic speech is an utterance where speech is in two words, which is laconic and efficient without conjunctions or articles. In this developmental stage, if the child says “Ball here, Doll there”, it is understood that the child means “Ball is here, the doll is there,” omitting the copula and articles. The words deleted or avoided in their utterances are closed-class or function words. So they are in simple, two-word, long sentences often composed of nouns and verbs. However, these telegraphic sentences, too, used to have simplified forms of the words with substitutions, omissions, reductions, and assimilations (i.e., with sound changes)

Even after three years, in the emergence of simple, compound, and complex sentences at least until age five, when almost all the complex language structure is acquired, children have these phonological deviations. That is, the production of the word with sound change is found to be normal. This sound change happens on a particular pattern. These pattern processes the children follow for their convenient production of the word are called phonological processes. It is a component of phonological acquisition. These processes are considered normal and found in every child worldwide during their word production stage. This sound change in word production is seen as normal unless they continue further, than the age at which most of the typically developing children have stopped using them (i.e., by age 7).

## 1.2. Sound Change and Speech Intelligibility

### 1.2.1. *Sound Change: Speech Difference or Speech Disorder*

Whenever ‘I’ (the researcher) talk about the sound change found among children in their developmental process (i.e., phonological acquisition and phonological disorders), I often get a question: what about the sound change that was seen among adults due to idiolects dialects and how do I account it with the sound change happens in the children. So here, I would like to explain the various sound changes in a language due to various factors. Also, it explains whether this sound change is a speech difference or a speech disorder. The term sound change is used as a technical term in historical linguistics as it is seen as part of diachronic and synchronic linguistics. Sound change is a change in the pronunciation of sound, which affects the unconscious knowledge of grammar as a generation of speakers is acquiring that knowledge. Since it takes place at the unconscious level, speakers are incapable of preventing it from taking place (Bhat, D.N.S., 2001). Many scholars have seen it as a common process that happens over a period. So, sound change is a change in the pronunciation of sounds. It takes place at an unconscious level as a generation of speakers is acquiring its first language. Phonetic and phonemic factors condition it. This sound change is not directly observable. Its occurrence has to be inferred by the effect that it leaves behind on the sounds of a language. Two kinds of evidence can be used for this purpose: (i) diachronic and synchronic. Diachronic is derived from a comparison of two sets of records of a language that belong to two different periods of time. Synchronic evidence, on the other hand, is derived either (a) from the descriptive study of a given language or (b) from the comparison of two or more dialects or languages that belong to the same period.

The two types of evidence differ from one another. The diachronic evidence called the external criterion provides a basis, namely the relative age of the two sets of records that are compared, for determining the direction in which the changes have occurred. However, no such basis is available in the case of the synchronic evidence. A more reliable basis for determining the nature and direction of change, an internal criterion, is provided by the descriptive as well as comparative studies of the dialects of a language.

### *Characteristics of sound change*

The internal criterion plays a significant role in sound change. Several points support the claim of a sound change in a language. They are due to diglossia, dialectal differences, hypercorrection, free variation, and child language acquisition.

a. *Diglossia*

Diglossia is the coexistence of two varieties of the same language throughout a speech community. Tamil is a diglossic language which has a standard (written) variety and spoken variety. For example

| Standard variety | Spoken form |
|---|---|
| mukt̪i ‘salvation’ | /mut̪t̪i/ |
| cejkirɑ:ɭ ‘(she) is doing’ | /cejjrɑ:/ |
| /po:kirɑ:ɾkɑɭ/ ‘(they) are going’ | /po:ɾɑ:ŋkɑ/ |

In the Standard variety /po:kirɑ:ɾkɑɭ/‘ki’ and ‘ɭ’ are deleted and r > ɾ, and ɾ> ŋ and uttered as /po:ɾɑ:ŋka/ in spoken form. So, the existence of a diglossic feature in a language yields sound change.

*b. Dialectal differences*

Dialectal differences are different forms of a language peculiar to a specific region (regional dialect) or social (social dialect) group. A dialect is differentiated by its pronunciation (phonology, including prosody), vocabulary, and grammar. Dialects can be classified into regional dialects as differences seen in different regions and social dialect differences seen in different social groups.

Various scholars have studied the regional and social variation of the Tamil language. Variations of /pɑɻɑm/‘fruit’ according to regional dialects of Tamil are Northern dialect /pɑjɑm/ (Chengalpatu, Vellore, Kanchipuram, Chennai), Western dialect /pɑɭɑm/ (Coimbatore, Salem, Dharmapuri, Nilgiri), Central dialect /pɑɻɑm/ (Trichy, Tanjore, Phudukottai, Cuddalore, Villupuram), Southern dialect /pɑlɑm/ (Madurai, Kanyakumari, Tirunelveli, Ramanathapuram), and Ceylon Tamil /pɑɻɑm/ and the variations of /ʋɑn̪t̪ʋiʈʈɑ:n/'he had come’ according to social dialects of Tamil are Bhramin dialect /ʋɑn̪t̪ʋɽʋt̪t̪ɨ/, dialect of scheduled caste /ʋɑn̪t̪uɾucci/, Chettiyaar dialect /ʋɑn̪t̪uʈʈɑ:n/, Muslim dialect, Vanniyar dialect /ʋɑn̪t̪uɽuccɨ/. Madurai dialect has metathesis, i.e., sound, reversals like kut̪iɾɑ ‘horse’>kuɾit̪ɑ.

*c. Hypercorrection*

Hypercorrection is the application of sound, word, or grammatical marker change in an inappropriate position, assuming that is an appropriate usage. According to Menner

(1937), hypercorrection happens when a real or imaginary grammatical rule is applied in an inappropriate context, so an effort to be "correct" leads to an incorrect result. It does not occur when a speaker follows "a natural speech instinct." For example, the Madurai dialect has a phonological problem in the pronunciation of '-ʒən', which is pronounced as '-ʃən'. For example, /kənfju:ʒən/ 'confusion' as /kənfju:ʃən/. As a hypercorrection, the community uses '-ʒən' in the place of '-ʃən'. For example, kənsɛʃən>kənsɛʒən and ətɛnʃən>ətɛnʒən.

*d.* *Free variation*

Free variation is the process of interchangeable relationship between two (or more) sounds occurring in the same environment with no change in meaning, and native speakers consider it as correct.

For example; /mɑkɑn/ ~ /mɑʋɑn/ 'son'
/ʋɑjɪrɨ/ ~ /ʋɑʋurɨ/ 'stomach'
/peʈʈi/ ~ /poʈʈi/ 'box'

*e.* *Child language acquisition*

Parents or relatives do not teach the language to the child. The family's adults speak to the child as they speak to other family members. Children exposed thus to the language acquire it without formal teaching. So, there is a much greater possibility to alter the sound according to the ease of their pronunciation. Also, the order of acquisition of sounds leads to these sound alterations. For example, children acquire stops before fricatives. So they try substituting stop sounds instead of fricative at that stage, as in /fæn/' fan'>/pæn/. Initially, the speech of the infant is unintelligible due to this. However, as age increases, these sound changes decrease. So, in the process of language acquisition, these sound changes, termed phonological processing, are developmental errors that will disappear at the age of 7. Also, their speech intelligibility increases as they master the phonology of their language/adult language.

### *1.2.2. Speech Intelligibility Vs. Phonological Processes*

Speech Intelligibility denotes the 'comprehensibility' of speech that matches the speaker's intention and the listener's reaction. It is the most instant norm by which a child's communicative attempts are judged. The more the sound change, which is a phonological process, in a child's speech, the less is the intelligibility, and the less the process, the more the intelligibility is. The known fact is that an increase in intelligibility is associated with an increase in chronological age. By three years, phonological processes would be reduced to 50 per cent, and the child's speech would be at least 50 per cent intelligible to unfamiliar adults. However, almost four to four and half years of age, a child's speech should be intelligible to unfamiliar adults (at least with 70 to 80 per cent intelligibility), even though some articulation and phonological differences are likely to be present but to a very lesser extent. So, the phonological processes decide the intelligibility of a child's speech.

Phonological processes are the designs that little children make use of to simplify adult speech. Every child uses these processes during the phase of their speech and language development. For example, the children of ages one to three years may say "nana" for "banana" or "date" for "gate." Some other children may leave out the final sound in words (for example, "ca" for "car" or "bi" for "big"). Up to age three, these are suitable productions. As children mature, they stop using these patterns to simplify words. In fact, by age five, about 90 per cent of children stop exercising all the phonological processes, and their speech looks more like the adults around them. As children stop using phonological processes, their speech becomes more understandable. This process allows them to become better communicators. For example, between one and a half years and two years of age, typically developing children may produce around 50 words. Between the ages of four and a half years and five years, children can produce up to 2,000 words. The children often do not listen to the differences in the words and will utter one word to mean two or three different ones. For example, children who remain to delete the initial consonant from a word may say “at” to mean each of these words: mat, bat, and cat. This processing tends to vanish by the age of three years in all the children during the developmental period.

**Phonological processes**

When children’s speech was analysed, very systematic and clear patterns were found in their erroneous approximations compared to adult utterances of words (Yavas, 1998). The error patterns found were uniform across children of all languages. One of the most regular ways of unfolding these error patterns is concerning phonological processes, which have been followed for a very long time. The phonological processes are natural and commonly occurring in typically developing children across languages. In normal child phonology, processes that never occur or rarely occur are called unusual or idiosyncratic processes (Stoel-Gammon and Dunn, 1985).

A phonological process is defined as a systematic sound change affecting an entire class of sounds or sound sequences. These processes are said to be phonetically motivated by articulatory, perceptual, or acoustic factors and involve simplifying a more complex articulation (Edwards and Shriberg, 1983). As children develop the phonological system, they may progress gradually from mastering the simpler sounds to the more complex sounds. During this period, they may use specific phonological processes, which allow them to simplify the adult form of speech until they are capable of correct production (Ingram, 1976) (cited in Hall, Oyer, and Hass, 1994). Phonological processes have been used to represent these simplifications (Ingram, 1976; Edward and Shriberg, 1983; Stoel-Gammon and Dunn, 1985; Hodson, 1980). These processes describe the error pattern evident in young children’s speech (Stoel-Gammon and Dunn, 1985).

The idea of phonological process in the studies of phonological acquisition and clinical assessment of child speech has been applied primarily as a descriptive tool that identifies or analyses systematic patterns in children’s pronunciations by comparison with adult pronunciations. Phonological processes are commonly occurring variations from adult speech patterns; may take place transversely in a class of sounds that alters a syllable shape or sequence (Hodson and Paden, 1983). Every child uses these processes during their speech and language development; when they mature, this simplification of words stops (Ranjan, 2009).

## Classification of phonological processes

In error patterns, the phonological process is a frequently used measurement method in a child's speech sound production since this method describes the relationship between the adult target and the child's production economically. Error patterns were categorized into two groups: syllable error patterns (errors that affect the syllabic structure of the target words) and substitution error patterns (errors involving substituting one sound for another) by Bernthal and Bankson (1998). However, Syllable processes have been divided into eight subcategories: final consonant deletion, weak syllable deletion, reduplication, consonant cluster reduction, assimilation, epenthesis, metathesis, and coalescence. Substitution error processes have been classified into eight subcategories: stopping, backing, fronting, deaffrication, vocalization, voicing, gliding of liquids, and affrication (Stoel-Gammon and Dunn, 1985; Dodd, 1995; Bernthal and Bankson, 1998).

Various classification systems of phonological processes have been devised, but they share commonalities (Hodson, 2004; Hodson and Paden, 1991; Ingram, 1989; Khan, 1985; Lowe, 1994; Shriberg and Kwiatkowski, 1985; Weiner, 1979). The following classification system classifies it into three main categories: Syllable structure processes, Substitution processes, and Assimilatory processes. The phonological processes of consonants described by various authors are summarized here.

## Syllable structure processes

These sound changes affect the word's syllable structure as the child attempts to produce the target word. The various syllable structure processes are as follows:

1. **Weak syllable deletion**
   Weak syllable deletion describes the omission of the unstressed syllable in a word of more than one syllable. This process is also called unstressed syllable deletion. This process occurs in normal children after the age of three. For example: banana > [nana], potato > [teto]
2. **Final consonant deletion**
   Deleting the final consonant in a word characterizes final consonant deletion (FCD). This deviation is sometimes referred to as an open syllable. Final consonant deletion is common in children between the ages of one year six months and three years but rare beyond three years (Ingram, 1989). For example: bus > [b^], bed > [bɛ]
3. **Initial consonant deletion**
   Initial consonant deletion (ICD) is characterized by the omission of an initial singleton consonant in a word. For example: coat > [ot], say > [e]
4. **Cluster reduction**
   Cluster reduction (CR) is the deviation in which one or more consonants in a consonant cluster are omitted. The deleted consonant can be a sonorant or an obstruent. For example: break > [bek], play > [pe]
5. **Syllable deletion**
   Syllable deletion (SD) is sometimes called syllable reduction. This process occurs when one or more syllables of a multisyllabic word are omitted. For example, telephone> [tɛfon], tomato > [medo]
6. **Epenthesis**
   Epenthesis can be defined as the addition of a sound in a word. The addition is often a vowel, although consonants are sometimes added as well. For example: black > [bəlæk], mud > [m^də]
7. **Metathesis**
   Metathesis is the pattern of transposing or reversing consonants in a word. For example: animal > [æmɪnʊl], elephant > [ɛfələnt]

8. **Coalescence**
   Coalescence is the pattern of merging a target cluster as a singleton, not either one of the segments of the target cluster. For example: train > [leɪn]

**Substitution processes**

Substitution processes relate the child's utterances to adult targets in which another class of phonemes replaces a class of phonemes. These deviations affect liquids, stops, fricatives, affricates, nasals, and glides. The various substitution processes are as follows:

1. **Fronting**
   Fronting refers to the replacement of a target phoneme with another phoneme that is articulated anterior to the target sound. Fronting is identified only when an anterior consonant replaces a posterior consonant (Hodson, 2004). Velar fronting is a common type in which alveolars are substituted for velars. For example, game > [dem], cow > [taʊ]
2. **Backing**
   Backing occurs when a target sound is replaced with another sound whose place of articulation is posterior to it; it also has been described as a posterior consonant replacing an anterior consonant (Hodson, 2004). This deviation seldom occurs and thus is considered an atypical deviation. For example: toe > [ko], seat > [hit]
3. **Gliding**
   Gliding refers to the use of a glide (/w, j/) for another consonant. Gliding occurs frequently on prevocalic liquids (/l, r/) in singletons and clusters, sometimes on fricatives. Gliding of fricatives occurs primarily in children with deviant phonology and is thus characterized as an atypical pattern, whereas gliding of liquids is typical during speech development. For example: rain > [wen], green > [gwin]
4. **Stopping**
   Stopping is the substitution of stops for continuants (Hodson and Paden, 1991). On the other hand, Edwards and Shriberg

(1983) indicated that stopping refers to fricatives, affricates, liquids, and glides being replaced by stops. Bernthal and Bankson (1990) described it as ‘stops’ replacing fricatives, affricates, and liquids. For example: sun> [t^n], van > [bæn]

5. **Vowelization**
   Vowelization is also called vocalization. This deviation occurs in which a vowel is substituted for a syllabic consonant. For example: bottle [bɑdo], car [kaʊ]

**Assimilatory processes**

These processes occur when two elements become more alike, usually regarding consonant place, manner, or voice. Vowel harmony may also occur but is not seen frequently in children of preschool age or older. Consonant harmony occurs when two or more segments become more alike. Assimilation can be progressive or regressive. Progressive assimilation occurs when a preceding sound influences a sound in a word; that is, a later sound in a word is changed. On the other hand, regressive assimilation occurs when a sound is influenced by a later sound so that an earlier sound in the word is changed.

1. **Voicing**
   Two types of voicing assimilation are commonly reported: prevocalic and final consonant devoicing. Prevocalic voicing refers to voicing an unvoiced consonant when it precedes a vowel. Ex: pig > [bɪg] and tag > [dæg]. On the other hand, Post-vocalic devoicing is changing a voiced obstruent at the end of a word to a voiceless obstruent. For example: pig > [pɪk] and bees > [bis].
2. **Reduplication**
   Reduplication refers to the complete repetition of one of the adult target syllables in a word. For example: water > [wawa], bottle > [baba]
3. **Alveolar assimilation**
   The child uses an alveolar sound for a non-alveolar (labial, velar) target due to a preceding or following alveolar

consonant in the word. For example, gate > [det] (regressive) boot > [bup] (progressive)

4. **Velar assimilation**
   The child uses a velar sound for a non-velar (labial, alveolar) target due to a preceding or following velar consonant in the word. For example, dog > [gɔg] (regressive), coat > [kok] (progressive)
5. **Denasalization**
   Denasalization occurs when a non-nasal sound replaces a nasal. This process occurs more frequently in word-initial, medial, and final positions. Ex: knock > [dak] smoke > [spok]

**Vowel process**

A vowel processing is a regular change in a vowel that affects features, complexity, or vowel harmony. Also, many types of research on vowel development in children suggest that the vowels of a language are the one which is acquired from the very beginning of the birth, both in production and perception. Although the emphasis of research on phonological development and phonological disorders has been on consonants, some studies have focused on the development of the vowel system (Pollack and Keiser, 1990; Reynolds, 1990; Ingram, 1976/89). Reynolds identified vowel patterns in children: lowering mid-front vowels (/ɛ/ to /ɑ/ (also noted by Stoel-Gammon and Herrington, 1990) and fronting low-back vowels to /ɑ/. Lowe (1994) and Pollack (1991) identified backing, fronting, raising, lowering, diphthongization, and vowel harmony in their study (Cited in Felicia Gironda and Renee Fabus, 2011). On the other hand, Ingram (1976/89) found vowel processes such as consonant-vowel harmony and vowel assimilation. The vowel substitutions explained in some research of typically developing children and those children with delayed development appear to be quite parallel but might differ with age (Stoel-Gammon and Dunn 1985, Pollock and Keiser 1990, Stoel-Gammon and Pollock 2008).

Otomo and Stoel-Gammon (1992) reported lowering of /ɪ/

to [ɛ] and /ɛ/ to [æ] as particularly frequent substitutions. Bleile (1989) describes diphthongization of /æ/ to [ɑi] in the speech of a 2-year-old child. Monophthongization is a context-sensitive substitution. It means that it occurs by the complete mutual assimilation of the parts of a diphthong; when /ɑi/ becomes [æ], the [ɑ] assimilates to the palatability of the following [i], and the [i] assimilates to the openness of the preceding [ɑ].

So the list of vowel processes accounted from various studies are;

1. **Vowel fronting**: A vowel is replaced with the tongue forward for a back vowel. For Example: /uɾɑl/ 'grinder' > /eɾɑl /
2. **Vowel backing:** A vowel is replaced with the tongue retracted for a front vowel. For Example: /sit/ 'sit' > /sut/
3. **Vowel lengthening:** A short vowel is lengthened. For Example: /ɑʈi/ 'beat' > /ɑ:ʈi/
4. **Vowel shortening:** A long vowel is shortened. For Example: /ɑ:ʈu/ 'goat' > /ɑʈu/
5. **Vowel lowering:** Front or back vowels are lowered to mid vowels. For Example: /piʈi/ 'catch' > /pɑʈi/
6. **Monophthongization:** Diphthong sounds are replaced with one vowel sound. For Example: / ɑ:mɑi/ 'tortoise' > /ɑmɑ/
7. **Diphthongization:** Making the target vowel into a combination of two vowel sounds. For Example: /kæt/ 'cat' > /kait/
8. **Vowel harmony:** The phonetic influence of one vowel for another. For Example, /ɑɳil/ 'squirrel' > /iɳil/
9. **Diphthong reduction:** Reduction of diphthong sounds in a word. For Example: /ʋɑ:jmɑi/ 'truth' > /ʋɑ:jɑm/

All these phonological processes are found in the usual child language acquisition, which is also a sound change, as seen in other characteristics of sound change. Here, the concern is to perform deep testing to confirm suspected patterns of developmental process and disorder and not a difference due to the idiolect of the parent or caretaker/dialect. Suppose the presence of sound change is due to non-standard form (diglossia) or dialectal variation. In that case, it is considered a speech difference and not a process in speech acquisition or speech disorder. However, a child speaking a non-standard dialect can also have a speech disorder. To rule out the sound changes of any other above-said criteria, the child's speech has to be compared with the dialectal adult form, which is supposed to be the child's caretaker. As said earlier, these processes are gradually eliminated when the child develops adult-like phonological skills. It might be a phonological disorder if it persists beyond age 6.

Parents and caregivers must be alarmed if a child's language milestones are noticeably behind (or different from) the language of same-aged peers. This alertness may persuade the parents to investigate further and, ultimately, take the child for a thorough evaluation by a professional. The first step of the assessment is to have the child's hearing checked. The child may not have a speech or language impairment at all but, rather, a hearing impairment that may interfere with his or her development of language. It is essential to realize that a language delay is not the same as a speech or language impairment. Language delay is a prevalent developmental problem; most commonly, it affects 5-10 per cent of children in preschool. Due to language delay, children's language will be developing in the expected sequence but at a slower rate. In contrast, language disorder refers to abnormality or deviation in language development.

Children with dyslexia, hearing impairment, autism, intellectual disabilities, ADHD, and developmental delay have more chances for this language disorder.

## Need for the current exploration

Study on Tamil phonological acquisition to set a norm for phonological development is a need of the hour. Since there is no research to a large extent in the field of phonological acquisition and disorders for the Tamil language is found, and there is no study done with an application of Optimality theory in this area, there is a vast need for these kinds of research in the Tamil language. This study needs to list the constraints in phonological acquisition and disorder and frame an intervention module for phonological disorder using optimality theory.

## The aim of the current investigation

The purpose of the inquiry is to identify the patterns of phonological acquisition, assess the phonological disorders, and plan an intervention module for phonological disorders using optimality theory. The present study uses Optimality Theory to describe the constraints using certain patterns of the words produced by Tamil children, which provides insight into the enduring underlying assumption - that universality may be found in the constraints. These patterns will be used to build a framework for Tamil phonological acquisition patterns and serve as a model for phonological development. The study plans to formulate a model for assessment and intervention using OT for the multiple processes found in their speech. From the date of the emergence of OT, it has its credits and criticisms. The criticisms were more on its application to phonology as its non-accountability of phonological opacity. However, the alterations and usage of chain shift methods led to the resolution of the problem. By chaining the words using constraints, the chain shift method seems to satisfy the problem of multiple processing.

## Objectives

The study plans:

1. To find out the constraints in the patterns of words produced by typically developing Tamil children.
2. To derive the method to find the relevant candidates responsible for multiple processing in a word.
3. To illustrate the universality and markedness in Tamil phonological acquisition.
4. To find out the constraints in the patterns of words produced by children with phonological disorders.
5. To formulate a model for assessment using OT.

6. To provide a methodology for intervention using OT for the multiple processes found in their speech.
7. To use the chain shift methods that lead to resolve the problem of multiple processing.

## 1.3. Methodology

For the present study, data has been collected (through audio recording) from 100 children of age one to six years (20 children in each age group, i.e., 1-2, 2-3, 3-4, 4-5, 5-6) and 100 children with phonological disorder due to various problems (50 children with cognitive delay, 30 with cerebral palsy and 20 with autism), for the analysis based on Optimality Theory. Linguistic principles were used to frame material for the data collection.

### Sample selection procedure

This study was conducted on a hundred typically developing (TD) Tamil-speaking children, ages ranging from one year to five years, and a hundred children with phonological disorders of Cognitive delay, Cerebral Palsy, and Autism.

100 Typically developing children were divided into five groups, with 20 children in each group divided by one-year intervals, as shown in Table 1. The children were screened for age-appropriate speech and language skills based on case history, observation, and assessment tools of language development (Extended Receptive and Expressive Emergent Language Scale (REELS; Bzoch and League, 1979). Other inclusionary norms of children were also included, like typical development of speech and language, normal hearing status, no negative medical history, and no developmental or neurological deficits, as reported in a parental interview. All subjects fit into the middle socio-economic status, and their parents had an educational qualification from 10th grade to master level. All children are Tamil native speakers. Their home language is Tamil, and they are exposed to Tamil and English in school.

Table 1. Distribution of typically developing children across age groups

| Age range | Male | Female | Total No. of Subjects |
|---|---|---|---|
| 1-2 | 10 | 10 | 20 |
| 2- 3 | 10 | 10 | 20 |
| 3- 4 | 10 | 10 | 20 |
| 4– 5 | 10 | 10 | 20 |
| 5- 6 | 10 | 10 | 20 |

One hundred children with phonological disorders were selected by random sampling method. Fifty children with cognitive delay, 30 with cerebral palsy, and 20 with autism were divided into five groups, with 20 children in each group divided by one-year intervals, as shown in Table 2. The disabilities have already been diagnosed by the special schools where they are studying. Using the Seguin form board, their IQ level were identified.

Table 2. Distribution of children with Language Disorders (LD) across age groups

| Age range | Cognitive Delay | | Cerebral Palsy | | Autism | | Total No. of Subjects |
|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | |
| 7-8 | 5 | 5 | 3 | 3 | 2 | 2 | 20 |
| 8-9 | 5 | 5 | 3 | 3 | 2 | 2 | 20 |
| 9-10 | 5 | 5 | 3 | 3 | 2 | 2 | 20 |
| 10-11 | 5 | 5 | 3 | 3 | 2 | 2 | 20 |
| 11-12 | 5 | 5 | 3 | 3 | 2 | 2 | 20 |

## Materials

The linguistic tool for the present research was formulated after a careful and comprehensive review of related literature. They are:

Assessment Material I: Phonological Profile
Assessment Material II: Story charts and general conversation.

***Description of the tools***

*Assessment material I*

The test material – I developed constitutes the following:

Stage 1: 1500 words in a combination of 18 consonants, 10 vowels, and two diphthongs in initial, medial, and final positions, and all possible clusters and borrowed words were selected from the children's early vocabulary books and textbooks.

Stage 2: These 1500 words are validated by linguists and speech-language therapists to see familiarity and comprehensibility, and 500 words were confirmed.

Stage 3: Using linguistic principles (i.e., occurrences of all vowels and consonants in all possible positions and clusters) and ease of production by children, 500 validated words have been reduced to 230 words. These words are meaningful, simple, easy, and familiar so that children can produce them within a short duration.

Stage 4: Finalised 230 meaningful di-syllabic and tri-syllabic words in a combination of 18 consonants, 10 vowels, and two diphthongs in initial, medial, and final positions and with the occurrences of all possible clusters and borrowed words are administered in 100 typically developing Tamil speaking and 100 children with phonological disorders

*Assessment material II:*
*Story charts*

Five known stories have been selected. Each story is depicted in the picture form, which is accommodated in a single page. These story charts are used to elicit spontaneous speech.

They are the Thirsty Crow, The Lion and the Bullocks, The Fox and the Crow, The Greedy Cats and the Monkey, and The Monkey and the Crocodile.

*General conversation*

The conversation about their day-to-day activities was observed.

If the child was not able to utter a stimulus word or narrate a story, verbal prompting was used to set off their speech.

**Progression in the analysis of speech development**

The speech samples collected from 100 typically developing children and 100 children with phonological disorders were transcribed using broad transcription of International phonetic transcription (IPA), and the phonological deviations in the children's speech were categorized under deletion, substitution, assimilation, metathesis, and cluster simplification. The data were analyzed using OT. So, the contents of this report are organized along the following lines according to the analysis and description of the intervention for phonological disorders using OT. The introductory chapter briefly details speech and language development and discusses the study's need, aim, and objectives; information about the subjects' materials used for data collection and the methodology adopted are covered. The second chapter describes the theoretical background of the phonology and its clinical use, the structure of Tamil phonology, and the Significance of Optimality Theory in the study of child phonology. The third chapter reviews all literature related to the study, describes the universals in phonological acquisition, explains the phonological analysis of typically developing children based on OT, and lists the constraints in Tamil phonological acquisition. The fourth chapter describes earlier studies in assessing Phonological Disorders (PD). Also, the influence of various disorders in assessment and assessment using OT for disorders are discussed. In the fifth chapter, earlier studies in the intervention of PD and the methods adopted by them, a method for ranking candidates using Chain Shifts for the intervention of multiple processing, and an Intervention model for phonological disorders and its efficacy with the evidence from the pre-test and post-test comparison are focused.

The sixth chapter, the final chapter, focuses on the duration taken for the constancy of speech using the intervention model and its applicability to other Indian Languages. It also points out the study's limitations and gives some suggestions for parents, teachers, and speech-language pathologists, those involved in the remediation of children's speech issues.

CHAPTER – 2

# Phonological Theories and Tamil Phonology: Clinical Perspective

## 2.1. Timeline of Phonology

### 2.1.1. *Phonology*

Phonology, the primary level of linguistics, is a base substance for establishing the higher levels like morphemes, words, and syntax. However, it is always considered to be an abstract/psychological entity. The goal of phonology is to study the properties of the sound systems (rule for the arrangement of sounds in a word), which speakers must learn or internalize to use the words in their language for the purpose of communication. Linguistics in the early twentieth century began investigating the phonologies of a variety of exotic and unfamiliar languages. Among these were American Indian languages, which (like all languages) contained hundreds of different sounds. To make the analysis of these sounds more manageable, the phonologists tried to organize these sound segments into groups. The essence of the phonological theory is the recognition that the speech sounds in a particular language can be grouped into classes called phonemes. Phonemes, in turn, are defined regarding contrast. A series of phonemic theories grew out of the need to organize large numbers of sounds in a language into a smaller number of more controllable groups and define the sound arrangement pattern in words.

## Phonological theories

Numerous phonology theories have emerged from the early twentieth century onwards, describing the phonological representations and processes.

- Linguistic Scientific Traditions (structuralists) 1920-1965 - Also called Classical phonemics/segmental phonology or structuralist phonology: Inventory of phones, phonemes, and their possible combinations are their primary focus.
- Generative Phonology 1965-1975: The main focus is on distinctive features in standard generative phonology (linear phonology). Linear phonology describes speech. A flow of speech is represented as a linear sequence of discrete sound segments. Each part is collected of simultaneously occurring features. Natural phonology is also part of linear phonology.
- Post Generative Phonology 1990s: Also non-linear models of phonology.

According to non-linear models, a speech stream is represented as multi-dimensional, not simply as a linear sequence of sound segments. The post-generative theories raised out of generative phonology are autosegmental phonology, metrical phonology, lexical phonology, and Optimality theory.

## Optimality theory

Optimality Theory (hereafter OT) is a technique developed in the 1990s by Prince & Smolensky to describe the language (Prince & Smolensky, 1991, 1993; Archangeli & Langendoen, 1997). OT is planned for the description of the entire grammar. However, its application to phonology has been dominant in recent years, even though theorists who proposed OT worked with the overall tradition of generative grammar (Archangeli, 1997).

### *An outline of the theory*

Optimality theory is often non-derivational when applied to phonology. OT does not seek to derive a surface realization from an underlying abstract form. To a certain extent, according to the use of language constraints, it assesses whether surface realization is well-formed. OT provides mappings from inputs to outputs where inputs are underlying representations and outputs are surface realizations. Also, according to the theory, it is claimed that the set of constraints is universal. However, the ranking of these and whether or not any particular constraint is variable or inviolable differs from language to language. All possible candidates then are evaluated in terms of the constraint ranking of the language. These candidates are impossible, and that of the possible forms is to be preferred and thus can be present according to the language. In the latter case, the last number of violable constraints is calculated, or when this number is the same between any candidates, the relative ranking of the broken violable constraints is taken into account.

As noted, the set of constraints in OT is claimed to be universal (Archangeli, 1997). As pointed out in Ball, Rutter, and Code (2008), there is no fixed universal set of constraints, either in terms of the total number of constraints or their character or their names; however, there is general agreement on a typology of constraints. Two broad categories are recognized (Archangeli, 1997): faithfulness constraints and markedness (or output) constraints.

Faithfulness constraints maintain faithfulness to the input that restricts the change in the output, i.e., constraints that compel identity between input and output forms. Markedness constraints assess the well-formedness of the output and allow changes to the output as much as possible i.e., motivate changes from the underlying form. These types usually differ in terms of their formalism too. Markedness constraints are generally found starting with an asterisk (the common linguistic usage implying something is not found), thus ***CODA** (consonants are prohibited in the syllable coda) and ***COMPLEXONSET** (consonant clusters are prohibited in the syllable onset). Faithfulness constraints rather can be seen as compelling rather than prohibiting, thus **MAX** (segments in the input must be in the output, without deletion of segments) and **IDENT** (segments in the input must be identical in the output, without substitution of segments). Using these constraints, constraint ranking can be used to show phonological differences between languages, varieties of a language, developmental stages in language learning, and between target and disordered realizations of phonology. Typically, the ranking of specific constraints with respect to each other is shown as follows where we rank relevant constraints for Tamil syllable Onsets.

**MAX-IO>>*ONSET, *COMPLEXONSET**

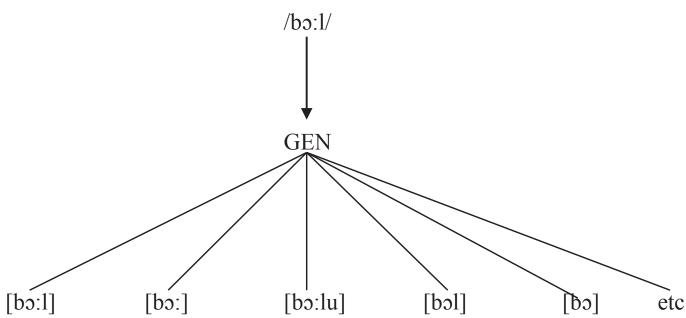
This ranking explains the requirement that the output is faithful to the input is more important in syllable onsets than the constraints against onset consonants or onset clusters. These last two are unranked with respect to each other here (though a ranking may be needed in other instances). An equals sign (=) may also be found between equally ranked constraints. This means that, in Tamil, syllables that start with vowels, singleton consonants, or consonant clusters may be found. If we do rank *ONSET above *COMPLEXONSET then that would imply that syllables beginning with clusters are more marked than those that do not.

*Operation of a constraints-based phonology*

The constraints are termed CON. There are two other components, GEN and EVAL in this theory.

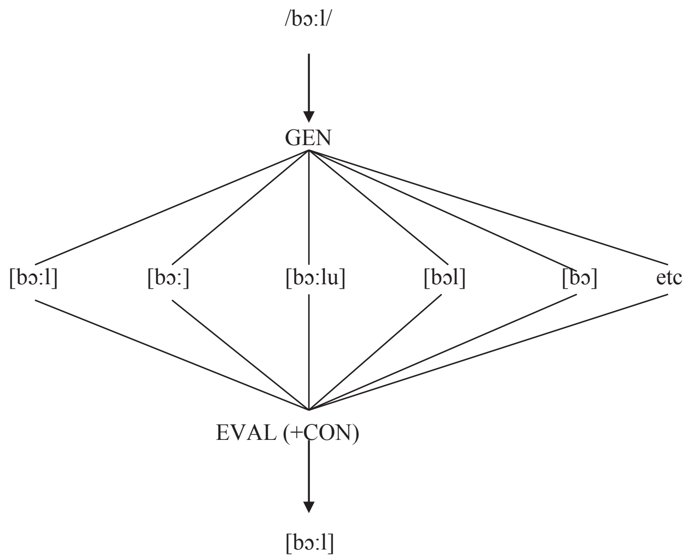
GEN is the component where candidate realizations are generated for any particular input form. For example, for English, the input /bɔ:l/ could potentially have a range of realizations, including [bɔ:l], [bɔ:], [bɔl], [bɔ:lu], [bɔ] and so on. GEN generates these (often characterized as an infinite possible set in OT). This can be seen in (1):

(1)



The EVAL component accesses the constraints and their rankings from the CON component and evaluates which particular candidate is optimal in that it violates the fewest constraints and/ or the fewest high-ranking constraints. If a candidate violates a violable constraint, then that is fatal and the candidate is excluded, even if it violates few others. We can expand (1) to illustrate the action of EVAL together with CON.

(2)




The tableaus are used to explain the candidate forms and how the optimal candidate was reached. Ball et al. (2010) illustrate a tableau (3) for onset clusters in English. The constraints involved and their rankings are:

**DEP-IO>>MAX-IO>>ONSET>>NO-CODA>>*COMPLEX**

**(DEP-IO** here means do not insert a vowel; **ONSET** means syllables must have an onset; **NO-CODA** means syllables should end with the vowel; ***COMPLEX** is a combination of ***COMPLEXCODA** and ***COMPLEXONSET).**

If we assume the input is the form /cleɪm/, then a tableau (3) can be drawn up as follows:

| /cleɪm/ | DEP-IO | MAX-IO | ONSET | NO-CODA | *COMPLEX |
|---|---|---|---|---|---|
| ☞[cleɪm] | | | | * | * |
| [ceɪm] | | *! | | * | |
| [ceɪ] | | *!* | | | |
| [cle] | | *!* | | | * |
| [cəleɪ] | *! | * | | | |
| [eɪm] | | *!* | * | * | |

In the tableau, the constraints are ranked from left to right across the top. The sign * denotes that a constraint is violated, ** that a constraint is violated twice. The "!" denotes that a fatal violation has occurred. The (☞) sign points to the optimal candidate; in this case, this form has only violated the low-ranked ***COMPLEX** constraint (even though twice with the initial cluster and final diphthong). This tableau points to the use of OT to describe phonological disorders, as some of the non-optimal candidates occur in phonological acquisition and delay.

### *Clinical application of OT*

The application of OT in the clinic has revolved mainly around constraint ranking. Incorrect realizations of target utterances are assumed to be the result of an incorrect ranking of the relevant constraints, which leads to the optimal candidate being other than that which the correct ranking would have indicated. This approach can also be used to account for patterns of normal development. For example, as noted in Ball et al. (2010), current thinking is that the child is born with a constraint ranking where output constraints are ranked above faithfulness constraints as default. The acquisition process, then, is one of the reranking constraints until they reach the same pattern of the adult language, becoming more marked and more faithful.

Much of the work on OT that has been applied to disordered speech has concentrated on child speech disorders (e.g., Stemberger & Bernhardt, 1997; Bernhardt & Stemberger, 1998; Barlow, 2001; and contributions to Dinnsen & Gierut, 2008b). For some common disordered patterns, OT can be applied straightforwardly. For example, final consonant deletion can be described by ranking the *CODA constraint higher in the child's speech than for the adult target language; indeed, if final consonant deletion is compulsory for a client, then the *CODA constraint is inviolable. The tableau in (4) shows how a child's production of /pɑ:l/ 'milk' may surface as [pɑ:]:

(4)

| / pɑ:l / | *CODA | IDENT-LENGTH | MAX |
|---|---|---|---|
| [pɑ:l] | *! | | |
| [pɑl] | | *! | |
| ☞ [pɑ] | | | * |

In (4), the output constraint *CODA outranks the faithfulness constraints **IDENT-LENGTH** (Length of the vowel input must be exact in-out) and **MAX,** producing the failure to realize the final consonant. A process of constraint demotion would bring about the constraint ranking in (4 a), which would, in turn, generate the correct form [pɑ:l].

(4 a) *~~CODA~~ >> **IDENT-LENGTH** >> **MAX** >> *CODA

However, bilabial consonant addition has occurred in Ball et al. (2008) data of 63-year-old male (CS) /bræp/ for /ræp/. The labial consonant addition process can only be accounted for in OT through the ad-hoc addition of a violable constraint requiring such addition (and, presumably, needed only for CS). Because such a constraint would not be needed for normal speakers, we show here only a tableau illustrating the variable use of this constraint in CS's speech:

Such 'invention' of constraints is problematic for a number of reasons. The GEN of OT has access to a supposedly universal constraint set that should permit no language-specific constraints, whether child or disordered client. To sanction the invention of constraints to handle specific phenomena is to reduce the theory's strength seriously. However, proposals have been put forward to account for such a nonrestrictive OT model of language acquisition. Pater (1997) has suggested that constraints may be able to 'come and go', which is likely during language acquisition and while the lexicon is expanding. Arguably, this could also happen in language breakdown.

### *OT and clinical intervention*

Optimality Theory (OT) is a framework used to analyse and explain phonological patterns and processes. It can also be used to diagnose and treat phonological disorders.

OT has not only been used to describe disordered speech data but also to inform therapeutic intervention. Some leading clinical phonologists within the OT tradition use the insights of a constraint-based approach in conceptualizing treatment. Barlow (2001: 252) states, "It is assumed that grammatical change occurs through constraint ranking."

Also, Dinnsen and Gierut (2008) say, "The clinical significance of fixed constraint ranking is that treatment aimed at the demotion of the top-ranked markedness constraint in a fixed hierarchy results in the demotion of the dominated markedness constraints (and hence the suppression of certain other error patterns) without directly treating the sounds associated with those lower ranked constraints." Here are some steps for using OT for phonological disorders:

1. Identify the phonological disorder: Before using OT, it is important to identify the specific phonological disorder that the patient is experiencing. This may involve analysing speech samples, conducting tests, and observing the patient's speech patterns in different contexts.
2. Identify the constraints: OT is based on the idea that a set of constraints or rules governs language. In the case of phonological disorders, these constraints may be violated, resulting in speech errors. It is important to identify the

specific constraints that are being violated in the patient's speech.

3. Develop a constraint ranking: Once the relevant constraints have been identified, they must be ranked in order of importance. This ranking will determine which constraint takes priority when a conflict exists between two or more constraints.
4. Develop a treatment plan: a treatment plan can be developed using the constraint ranking to address the patient's phonological disorder. This may involve targeting specific constraints through various exercises and drills.
5. Evaluate progress: As the patient receives treatment, monitoring their progress and adjusting the treatment plan as needed is essential. OT can be used to evaluate the effectiveness of the treatment and make any necessary adjustments to the constraint ranking or treatment plan.

Overall, OT can be useful for diagnosing and treating phonological disorders. By identifying the relevant constraints and developing a constraint ranking, clinicians can develop targeted treatment plans that address the specific needs of each patient.

## 2.2. Tamil Phonology

This section briefly describes the Tamil language and the structure of the Tamil segmental phonology. It also gives the structure of Tamil phonology that was found in the period of Tolkappiyam and that which is found in the modern age. The primary purpose of this section is to expose the phonological pattern of standard Tamil.

### 2.2.1. *Introduction about Tamil*

Tamil (t̪ɑmiɻ), which has its classic status, is one of the leading literary languages of the Dravidian languages spoken in Southern India, predominantly by the people of Tamil Nadu, Puducherry, Andaman, and the Nicobar Islands and Sri Lanka. It has official status in the Indian states, viz. Tamil Nadu, Puducherry, Andaman, and the Nicobar Islands. Tamil is characterized by distinguishing phonemic, morphophonemic, syntactic, and stylistic features. Agglutination of suffixing morphemes, free order of words in sentences, and head-final structure of phrases distinguish this language from other European languages. The complex nature of this language is also accounted for its diglossic characteristics with the presence of both high and low varieties, besides a vast number of registers and dialects. The diglossic situation in Tamil reveals the use of two varieties of language in the Tamil speech community with structural and functional differentiation, and these varieties are named as both high variety and low variety or as written variety and spoken variety, respectively (as discussed in Chapter 1). The high or written variety is used in formal settings, whereas the low or spoken variety is used in informal contexts. Also, Tamil is a language spoken by a large number of speakers, and so it has developed some social (sociolects) and regional dialects. Despite these variations in Tamil, a standard form of the language is used for official purposes and public communication. Though these dialects, are differentiated as different varieties, reflect the richness of language and are often used in the language, especially in the creation of functional and standard varieties.

## Inventory of phonemes

The Tamil phonology has 12 vowels, 18 consonants, and one unique character ஃ. ஃ is pronounced as “ɑkku” and is classified in Tamil grammar as neither a consonant nor a vowel.

The basic vowel forms and their phonemic and phonetic correspondents are given below (Steever 1996):

| | | |
|---|---|---|
| அ | /ɑ/ | [ʌ] |
| ஆ | /ɑ:/ | [ɑː] |
| இ | /i/ | [i] |
| ஈ | /i:/ | [iː] |

| | | |
|---|---|---|
| உ | /u/ | [u] |
| ஊ | /uː/ | [uː] |
| எ | /e/ | [e] |
| ஏ | /eː/ | [eː] |
| ஐ | /ɑi/ | [ʌj] |
| ஒ | /o/ | [o] |
| ஓ | /oː/ | [oː] |
| ஔ | /ɑu/ | [ʌʊ] |

The basic consonantal forms and their phonemic and phonetic correspondents are given below (Steever 1996):

| | | |
|---|---|---|
| க் | /k/ | [k], [g], [x], [ɣ], [h] |
| ங் | /ŋ/ | [ŋ] |
| ச் | /c/ | [tʃ], [dʒ], [ʃ], [s], [ʒ] |
| ஞ் | /ɲ/ | [ɲ] |
| ட் | /ʈ/ | [ʈ], [ɖ], [ɽ] |
| ண் | /ɳ/ | [ɳ] |
| த் | /t̪/ | [t̪], [d], [ð] |
| ந் | /n̪/ | [n̪] |
| ப் | /p/ | [p], [b], [β] |
| ம் | /m/ | [m] |
| ய் | /j/ | [j] |
| ர் | /ɾ/ | [ɾ] |
| ல் | /l/ | [l] |
| வ் | /ʋ/ | [ʋ] |

| | | |
|---|---|---|
| ழ் | /ɻ/ | [ɻ] |
| ள் | /ɭ/ | [ɭ] |
| ற் | /r/ | [r], [t], [d] |
| ன் | /n/ | [n] |

The grantha letters formed to use for borrowed words from Sanskrit and their phonemic and phonetic correspondents are given below:

| | | |
|---|---|---|
| ஜ் | /ɟ/ | [dʒ] |
| ஷ் | /ʂ/ | [ʂ] |
| ஸ் | /s/ | [s] |
| ஹ் | /h/ | [h] |
| க்ஷ் | /kʂ/ | [kʂ] |

The combination of consonant and vowel leads to an additional 216 letters representing 247 combinations (*uyirmeyyeḻuttu*), a mute consonant, or a vowel alone. These combined letters are formed by adding a vowel to the consonant.

**Tolkappiyar's phonological pattern**

The phonological pattern that existed at the age of Tolkappiyam has been presented briefly below. This helps one compare the old Tamil phonological structure with the modern Tamil phonological structure.

Tolkappiyar identifies 12 vowels and 18 consonants in Tamil. They are classified in the following way:

***Vowels***

/kurreɻuṯṯu/ (short) - /ɑ, i, u, e, o/, and /neʈʈeɻuṯṯu/ (long) - /ɑ:, i:, u:, e:, o:, ɑi, ɑu/

***Consonants***

/ʋɑllinɑm/ (plosives) - /k. c, ʈ, t̪, p. r/, /mellinɑm/ (nasals) - /ɲ, ŋ, n, n̪, m, ɳ/, /iʈɑijinɑm/ (midlings) - /j, ɾ, l, ʋ, ɭ, ɻ/

**Dependant sounds (cɑ:ɾpeɻuʈʈu):**

The occurrences of these sounds are conditional. They are: 1. kurrijalikaɾam (shortened '-i'), 2. kurrijalukaɾam (shortened '-u'), 3. ɑ:jʈ̪ɑm (k)

***Phonotactics***

*Initial position*

Vowels: All the vowels occur in the initial position.
Consonants: The only consonants /k, t̪, n̪, p, m, c, ʋ, ɲ, j, ʈ/ occur initially.

*Final position*

Vowels: In the age of Tolkappiyam, all the vowels except diphthong /ɑu/ occurred finally. The diphthong /ɑu/ also occurred finally, but its occurrence was conditioned that it had to be preceded by /k/ or /ʋ/.

Consonants: During Tolkappiyar's period, of the 18 consonants, the consonants /ɳ, ɲ, ŋ, n, j, ɾ, 1, ʋ, ɻ, ɭ/ occurred in the word-final position.

***Sequential occurrence of phonemes***

Vowels (ɑɭɑpeʈɑi): In the age of Tolkappiyam, a short vowel was added after the long vowel to meet with the metrical deficiency.

***Consonant clusters:*** Two types of consonantal clusters that occurred word medially were reported to be found in Tamil during the period of Tolkappiyar. They are :

1. Cluster with non-identical consonants (mejmɑjɑŋku)
2. The occurrence of identical consonants in a sequence (uʈanilai) - i.e., gemination.

***Clustering of non-identical consonants***

There were clusters formed by adding sounds of one type of consonant with another consonant. They were the following:

/-ʈk-, -ʈc-, -ʈp-, -rk-, -rc-, -rp-, -lk-, -lc-, -lp-, -ɭk-, -ɭc-, -ɭp-, -lj-, -lʋ-, **-ɭj-**, **-ɭʋ-**, **-ŋk-**, **-ɲc-**, **-ɳʈ-**, -n̪t̪-, **-**mp-, -nr-, **-ɳk-**, **-ɳc-**, **-ɳɲ-** , **-ɳp-**, **-ɳm-** , **-ɳj-** , **-ɳʋ-** , -nk-, -nc-, -nɲ-, -np-, -nm-, -nj-, -nʋ-, **-ɲj-**, -n̪j-, -mj-, **-ʋj-**, -mʋ-, -jk-, -jt̪-, -jn̪-, -jp-, -jm-, -jc-, -jɲ-, -jj-, -jʋ-, -jŋ-, **-ɾk-**, **-ɾt̪-, -ɾn̪-, -ɾp-**, **-ɾm-**, **-ɾc-**, **-ɾɲ-**, **-ɾj-**, **-ɾʋ-**, **-ɾŋ-**, **-ɭk-**, **-ɭt̪-, -ɭn̪-, -ɭp-**, **-ɭm-**, **-ɭc-**, **-ɭɲ-**, **-ɭj-**, **-ɭʋ-**, **-ɭŋ-**,/

***Clustering of identical consonants -Gemination***

All the consonants except /ɾ/ and */ɻ/* occur in gemination. They are, /-kk-, -cc-, -t̪t̪-, **-ʈʈ**-, -pp-, -rr-, **-ɳɳ-**, -n̪n̪-, **-ŋŋ-**, **-ɲɲ-**, -mm-, -nn-, -jj-, -ll-, **-ʋʋ-**, **-ɭɭ**-/

***Three consonantal clusters***

Medial position

The midlings /j, ɾ, ɭ/ were combined with the following geminations /-kk-, -cc-, -t̪t̪-, **-pp-, - ŋŋ-**, -n̪n̪-, **- ɲɲ-**, -mm-/ to form the following clusters. /-jkk-, -jcc-, -jt̪t̪-, **-**jpp-, -jŋŋ-, -jn̪n̪-, **-**jɲɲ-, -jmm-, **-ɾkk-**, **-ɾcc-**, **-ɾt̪t̪-, -ɾpp-**, **-ɾŋŋ-**, **-ɾn̪n̪-, -ɾɲɲ-**, **-ɾmm-**, **-ɭkk-**, **-ɭcc-**, **-ɭt̪t̪-, -ɭpp-**, **-ɭŋŋ-**, **-ɭn̪n̪-, -ɭɲɲ-**, **-ɭmm**-/

Final position

In the Tamil of Tolkappiyam period, only one cluster is reported to have occurred in the word-final position. The alveolar nasal, /n/, and a labial nasal /m/ appeared in a cluster form /nm/ in poetry. The same cluster is not found in any other works reported by Tolkappiyam (eg. /po:nm/'po:lum').

**The phonological structure of modern Tamil**

In this section, a clear picture of the phonology of modern Tamil is given. There are some differences between the phonological structure of Tamil provided by Tolkappiyar and that found in modern Tamil. This part of the chapter provides only the structure of segmental phonology.

### *Segmental phonology*

Under segmental phonology, the sounds are grouped into vowels, diphthongs, and consonants.

### *Vowels*

Vowels are classified as Monophthongs and Diphthongs. Monophthongs are further divided by their length of pronunciation, like short and long vowels. Monophthongs are vowels in which the articulation is almost unchanging. The vowel is a syllable that can be pronounced with the free passage of air. ɑ, e, i, o, and u always represent vowels. A vowel can be a free syllable or combined with a consonant to form a syllable. In the articulation of diphthongs, the articulators glide from the position of one vowel to another within a syllable. The starting point, the nucleus, is strong and distinct. Also, the letters ‘ʋ’ and ‘j’ sometimes represent semi-vowels. Diphthongs are a combination of two vowels. However, it is pronounced as a single sound. For example, ‘ɑu,’ as pronounced in the word /ɑuʋɑijɑːɾ/ is a diphthong. These sounds create difficulty for the speaker. So, the typically developing children make many phonological processes in the vowels in their developmental stages.

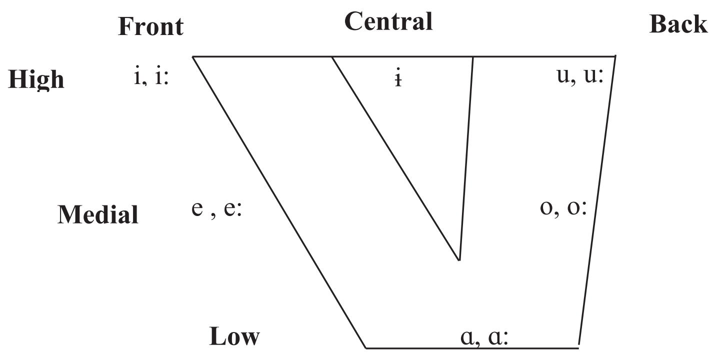
Ten vowels are found in modern Tamil, of which five are short, and five are long. They are: Short vowels: /i, e, ɑ, o, u/, and Long vowels: /iː, eː, ɑː, oː, uː/

In these, /i, iː, e, eː/are known as front vowels, /ɑ, ɑː/ as central vowels, and /o, oː, u, uː/as back vowels.

Vowels are also classified by the height of the tongue as follows.

High vowels - /i, iː, u, uː/, Mid vowels - /e, eː, o, oː/, and Low vowels - /ɑ, ɑː/

**Figure: (5) Shows the Place of Articulation of Vowels**




Apart from the vowels shown in Figure 5, Tamil has the two diphthongs ɑu, ɑi.

Table 3: Shows the vowel system in Tamil.

| Height | Front (Unrounded) | | Central (Unrounded) | | Back (Rounded) | |
|---|---|---|---|---|---|---|
| | Short | Long | Short | Long | Short | Long |
| High | i | i: | ɨ | | u | u: |
| Middle | e | e: | | | o | o: |
| Low | | | ɑ | ɑ: | | |
| Diphthongs | ɑi ɑu | | | | | |

*Tamil vowel alternates*

A vowel phoneme, according to its position in the word, substitution or elision of the sound happens in spoken form. There are well-defined rules for this process in Tamil. They are categorized into different classes based on the phoneme, which undergoes elision.

1. the vowel *u* becomes 'ɨ' in word-final position

2. the vowel *i b*ecomes ‘j’ in word-final position
3. the diphthong *ai b*ecomes ‘e’ in word-final position

### *Consonants*

The consonants are classified based on two broad classifications. They are the place of articulation and manner of articulation.

The Tamil consonants are classified as two major parts, as in (6). They are

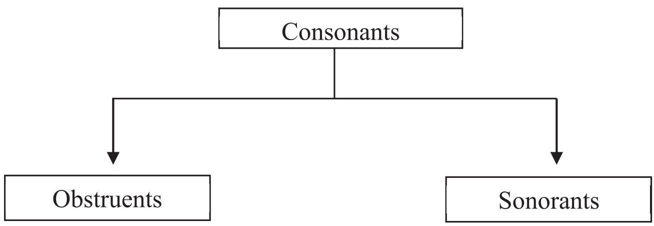



Figure (6)

*Obstruent in Tamil phonology*

Tamil Phonology is categorized by consonants (which are further classified into Sonorants and Obstruents) and vowels. The Tamil language does not differentiate between voiced and unvoiced consonants phonologically, but phonetically, voiced is assigned depending on a word’s position of occurrence. Also, fricatives are not part of the phonemes of the language. Tamil phonology does not permit few consonant clusters in word-initial position. But the loan words in Tamil have an exemption to this rule. In Tamil phonemes, obstruents have an essential role in forming the words. An obstruent is a consonant such as /k/or /p/ that is formed by obstructing airflow in the oral cavity, causing a strong incline of air pressure in the vocal tract. Obstruents are in contrast with Sonorants, which have no such obstruction. Obstruents are divided into stops and fricatives. The stop sounds are [p, t, k, b, d, g, c, ɖ, ɟ, ʈ ], with complete obstruction of the vocal tract, often followed by a release burst. The fricatives are [f, s, ʃ, x, v, z, ʒ, ɣ], with narrow closure, without stopping the airflow but making it turbulent.

*Sonorant in Tamil phonology*

Sonorants are called so because of their free air flow via the vocal tract. Hence, resonance (feature for voicing) is, however, possible. Sonorants restrict airflow in the vocal tract more than vowels. In Tamil, sonorants include laterals, approximants, nasal consonants, taps, and trills. The nasals are like the stops phonemes. Nasals have a stricture of complete closure in the oral cavity. However, the soft palate is lowered, allowing the air stream to escape through the nose. The Tamil nasal phonemes are /n/, /ɲ/, /ɳ/, /n̪/, /ŋ/. Trills and taps are produced between the active and passive articulators with a rapid percussive action. The trill /r/ most frequently occurs in the middle and final. A single rapid percussive movement is termed a tap. Tamil has a contrast of a tap /ɾ/. Laterals are made with the centre of the tongue, forming a closure with the roof of the mouth, but the sides are lowered. Typically, the airstream escapes without friction, producing a lateral approximant. Tamil laterals are /l/, /ɻ/, /ɭ/.

Regarding consonants, some sounds are found to be peculiar to the Tamil language only. The dental and retroflex nasals (n̪, ɳ), the retroflex lateral (ɭ), the alveolar trill (r), and the voiced retroflex continuant lateral (lateral approximant) (ɻ) are considered exceptional feature occurrences to the Tamil language.

There are certain practices in pronouncing these peculiar sounds, like those phonetically similar sounds that confuse the speaker.

The following chart shows the common consonants in most native Tamil dialects. The column indicates the manner of articulation; the first row indicates the place of articulation.

Table 4: Shows the Tamil Consonant System with Phones and Allophones

| Place of articulation<br>Manner<br>of articulation | Bilabial | Labio-dental | Dental | Alveolar | Retroflex | Palatal | Velar | Glottal |
|---|---|---|---|---|---|---|---|---|
| Stop | p b | | t̪ d̪ | | ʈ ɖ | c ɟ | k g | |
| Nasal | m | | n̪ | n | ɳ | ɲ | ŋ | |
| Flap/Tap | | | | ɾ | ɽ | | | |
| Trill | | | | r | | | | |
| Fricative | β~ʋ | | θ | s | ʂ | ʃ | x | h |
| Approximant | | ʋ | | | ɻ | j | | |
| Lateral approximant | | | | l | ɭ | | | |

The allophones are identified by the occurrence of phonemes in the word level with the vowel.

### *Tamil stop allophones*

The voiced stops, fricatives, and retroflex flap are not part of the Tamil orthography. Stops are pronounced as voiced after nasals; velar, bilabial palatal, and dental phonemes are changed as fricative in the intervocalic position, and retroflex phonemes are changed as a flap in the intervocalic position. Voiced palatal stop/affricate and alveolar, palatal, and velar fricatives are given orthography to represent borrowed/loan words in the aspect of S. Agesthialingam (2002).

Table 5: Shows the possible allophones in Tamil consonants

| Phoneme | Allophone | After nasal | Between two vowel |
|---|---|---|---|
| K | g | + | - |
| | x | - | + |
| ʈ | ɽ | - | + |
| | ɖ | + | - |

| | | | |
|---|---|---|---|
| t̪ | d̪ | + | - |
| | θ | - | + |
| | ð | + | - |
| P | b | + | - |
| | β | - | + |
| C | ʃ | - | + |
| | ɟ | + | - |

The following figure (7) represents the overall picture of Tamil consonantal system with phonemes and allophones.

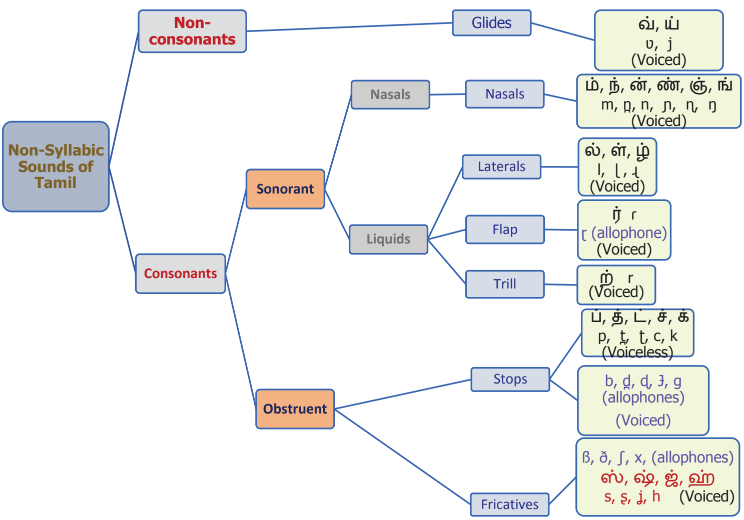



Figure (7)

## Syllable in Tamil

Kager (1999: 91) proposes that syllables can provide proper phonological generalizations, define phonological patterns, and verify the well-formedness of the sequence of the segments. On this basis, he believes that all repairing options, namely, epenthesis, deletion, alternation, etc., are triggered at the intersections performing unitary functions – avoiding syllable ill-formedness. Tamil has few studies that have nominated the role of syllables (Kothandaraman, 1999a; Ravisankar, 1994). Exceptional studies such as Vasanthakumari (1989), Kothandaraman (1999a), and Christdas (1988) have achieved modest success in verifying its importance in solving morphophonological-related issues.

Traditionally, the syllable is conceived as having an essential core of high sonority nucleus, preceded optionally by a low sonority onset and followed, again optionally, by a low sonority coda. Typically, the nucleus is a vowel (V), and the onset and coda are consonantal (C). Thus, the basic syllable pattern of Tamil is V, CV, VC, and CVC, and usually, VC syllables would be expected to be found at word beginnings only.

Many languages allow more than one C to be assigned to the onset and coda positions, leading to C clusters at these positions. However, the syllable structure of Tamil avoids consonant clusters in the word's initial position so that there is maximally only one C at the word beginning and at the word end, and word internally, there are maximally only two Cs (three only for Word formation in morphological level, For example as in pɑ:ɾt̪t̪ɑ where /pɑ:ɾ/ 'see' /-t̪t̪-/ 'past tense marker and /-ɑ/ 'participle marker,'), at coda-onset junctions. When strings with C clusters that do not conform to this limit are encountered in a language of this type (as a result of morphological concatenation or borrowings from languages that do allow such clusters), phonological processes are set in, firstly to alter the segmented string by the introduction of or deletion of segments as appropriate (as in deletion of /t/ in train), and then to resyllabify the altered string to achieve the preferred syllable shapes for the language. However, Tamil vowel phonemes contrast for length, which leads to an extension of the syllabification pattern discussed earlier into V, VV, $V_1V_2$, CV, CVV, $CV_1V_2$, CVC, CVVC, $CV_1V_2C$, and VC, where VV is the lengthening of same vowel, and $V_1V_2$ is the occurrence of the diphthong.

**Distribution of phonemes - phonotactics**

Every language is built with rules and constraints. Though linguistic universals are there among world languages, each language has its individualities, from the sound system to sentence structure. These variations found in all language levels have attracted much interest from linguists worldwide. The variation found in sound sequences and syllable structure has also been a prime interest of study by many linguists. Phonotactics is a part or branch of the phonology of a language that deals with the constraints of the possible sound sequences (like consonant clusters and vowel sequences) and syllable structures in a language. So, Phonotactics is concerned with the freedoms and restrictions that language allows regarding syllable structure. It gives out the rule of that language's sound system, saying which sounds can precede and follow. For example, in Tamil, consonant clusters do not occur in the word-initial position (no complex onset), whereas it is found more in English (has a complex onset very much). In some Slavic languages, /l/ and /r/ are used as vowels. According to Agesthialingam (2002), occurrences of consonants in the word level are given below.

Table 6: Shows the occurrence of consonants in the word level

| Consonants \ Place | Initially | Medially | Finally |
|---|---|---|---|
| p | + | + | - |
| t̪ | + | + | - |
| r | - | + | - |
| ʈ | - | + | - |
| k | + | + | - |
| c | + | + | - |
| m | + | + | + |
| n | + | + | - |
| n̪ | - | + | + |
| ɳ | - | + | + |
| ɲ | + | + | - |

| | | | |
|---|---|---|---|
| ŋ | - | + | - |
| l | + | + | + |
| ɭ | - | + | + |
| ʎ | - | + | + |
| ɾ | + | + | + |
| ʋ | + | + | - |
| j | + | + | + |

The Tamil language contains a lot of borrowed words from Sanskrit and English (see Appendix 1) because of the nativization process. The phonemes of borrowed words are also classified by the place of occurrence in the word. The given table contains phonemes that are borrowed from other languages.

Table 7: Shows the phonemes occurrence of the borrowed words

| Borrowed phonemes | Initial | Medial | Final |
|---|---|---|---|
| s | + | + | + |
| ʂ | + | + | - |
| kʂ | + | + | - |
| f | + | - | - |
| ɟ | + | + | + |
| ʃ | + | + | + |
| z | + | + | + |
| h | + | + | - |
| ʒ | + | + | - |

Tamil phonology allows a few consonant clusters that can never be in the word's initial position. However, the Tamil language has loan words with word-initial consonant clusters. They are geminated clusters (pp, t̪t̪, ʈʈ, kk, cc, mm, nn, ɳɳ, n̪n̪, **ŋŋ**, νν, jj, ll, **ɭɭ**, rr, **ʋʋ**) and non-geminated clusters (mp, n̪t̪, ʈc, nm, nr, ɳʈ, ɳk, νc, nj, rk, etc.,). According to S. Agesthialingam (2002), combining two consonants is called clusters. The given table contains two different types of consonant clusters. They are geminated clusters and non-geminated clusters.

Table 8: Shows the combination of two consonant clusters in the Tamil language

| phonemes | p | t̪ | r | ʈ | k | c | m | n̪ | N | ɳ | ɲ | ŋ | l | ɭ | ɻ | ɾ | ʋ | j |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| p | + | + | + | + | - | - | + | - | + | + | - | - | + | + | + | + | - | + |
| t̪ | - | + | - | - | + | - | - | + | - | - | - | - | - | - | + | + | - | + |
| r | - | - | + | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - |
| ʈ | - | - | - | + | - | - | - | - | - | + | - | - | - | - | - | - | - | - |
| k | - | - | + | + | + | - | - | - | + | + | - | + | + | + | + | + | - | + |
| c | - | - | + | + | - | + | - | - | + | - | + | - | + | - | - | - | - | - |
| m | - | + | - | - | - | - | + | - | + | + | - | - | - | - | + | + | - | + |
| n̪ | - | - | - | - | - | - | - | + | - | - | - | - | - | - | + | + | - | + |
| n | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - |
| ɳ | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - |
| ɲ | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - |
| ŋ | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - |
| l | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - |
| ɭ | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - |
| ɻ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ɾ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ʋ | - | - | - | - | - | - | - | - | - | - | - | - | + | + | + | + | + | + |
| j | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | + |

Three consonant clusters in Tamil listed according to S. Agesthialingam (2002) are given in Table 9:

Table 9: Shows the three consonant clusters in the Tamil language

| Initial consonant | Two same stop | | | | Two same nasal | the combination of Nasal and Stop | |
|---|---|---|---|---|---|---|---|
| | pp | t̪t̪ | kk | cc | mm | mp | n̪t̪ |
| J | + | + | + | + | + | + | + |
| ɾ | + | + | + | + | - | - | + |
| ɻ | + | + | + | + | - | - | + |

According to S. Agesthialingam (2002), the vowel position in the word is distributed.

Table 10: Shows the vowel occurrence in the word level

| Place | Phoneme | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | i | i: | e | e: | u | u: | o | o: | ɑ | ɑ: | ɑi | ɑu |
| Initial | + | + | + | + | + | + | + | + | + | + | + | + |
| Medial | + | + | + | + | + | + | + | + | + | + | + | + |
| Final | + | + | - | + | + | + | + | - | + | + | + | - |

**Descriptive studies of Tamil phonology**

Many authors like Asher (1985), Kamil Zvelebil (1964, 1970), Agestialingam (1967, 2002), S. Rajaram (1972, 1980), A.H. Arden (1976), Pon Kothandaraman (1997), Ramasamy Mohana Dass (2005), K. Karunakaran (1986), and T. Balasubramanian, (1980) have described phonology in their studies on Tamil language. Their descriptive accounts have been collectively used in the description of phonology in the present study. Dialectal Studies by Kamil Zvelebil (1966) K. Karunakaran (1971, 1975, 1976), T. Edward Williams and Jeyapaul (1977), Y. C. Yesudhason, (1977), K. Ramaswamy (1978), S. Sakthivel (1978), K.M. Irulappan (1979), G. Srinivasa Varma (1980), C. Sivashanmugam (1981),

K. Karunakaran and C. Sivashanmugam (1981) and V. Thayalan (1986) have given a description on the Tamil phonology of particular dialects they have studied.

**Distinctive feature description for the Tamil phonemes**

A generative study by Vasanthakumari (1989) offers phonological treatment for morphology-phonology interactions in the Madurai dialect. This dialect is spoken in the region located in southwest Tamil Nadu, South India. The study explains various generative rules of verb and noun formations and inflections. She has given a detailed feature description for the Tamil phonemes. The major features she has described for Tamil phonemes are:

Major class features: Syllabic, Sonorant, Consonantal
Manner of features: Continuant, Nasal, Lateral
Place of Articulation features: Anterior, Coronal
Body of tongue features: High, Low Back
Subsidiary features: Voiced
Prosodic feature: Tense/Lax

**The lexical phonology (a study of the Kanyakumari dialect)**

Christdas (1988), a significant linguistic study done within the framework of Lexical Phonology, is another dialectal study with a special focus on the Phonology and Morphology of Tamil. Empirical data for the study was obtained from a dialectal Tamil spoken in the Nagercoil district in South India. The manual considers Phonology and Morphophonology as a single domain of study consisting of some exciting and controversial findings. Besides offering a range of significant contributions to the Lexical Phonology of Tamil nouns and verbs, it also consists of some overgeneralizations. Perception of UR and epenthesis classification is one of them. A controversial contribution of Christdas is a classification of epenthesis, which challenges the rule of the majority in Tamil. For example, Christdas claims that all noun stems are consonant final in UR (Christdas, 1988: 349); the claim can be reinterpreted as the language does not have vowel-final stems. This is controversial when verified with the help of the following examples ending with vowels '$V_1V_2$': /vɑlɑi/ 'net,'/t̪ɑlɑi/ 'head,'/kɑi/ 'hand,' and /mɑlɑi/ 'mountain.' The issue of epenthesis, too, has to be restated.

**The constraint-based study**

There are two constraint-based studies by the same author, Beckman, on Tamil. One of them is *On the Status of CODACOND in Phonology* (2004), and the other is a thesis entitled *Positional Faithfulness* (1997). These studies have depended heavily upon secondary data from Christdas (1988). Beckman established that the language provides encouraging evidence to support the study of Positional Faithfulness, a crucial element that claims to determine the directionality of morphophonological activities. Beckman's analysis also accounts for a range of repairing strategies aiming at harmonizing Onset/Coda asymmetries, such as nasal place assimilation, lateral assimilation (when necessary), no assimilation to non-coronal segments, and lastly, epenthesis in an obstruent-obstruent cluster.

With a brief description of phonology and its application in clinical settings and a description of the Phonological structure of Tamil, the study looks into the earlier studies on phonological acquisition. It analyses the Tamil data of phonological acquisition using OT.

CHAPTER – 3

# An OT Perspective on Phonological Acquisition

The study of phonological acquisition started in the late nineteenth century, and this field has been transformed and developed over the years by various developments in phonological theory.

## 3.1. Studies in Phonological Acquisition (Western Scholars)

The study on phonological acquisition initially started with the interest of parents and scientists to explore the language development of children [Darwin (1877), Humphreys (1880), Preyer (1889), and Deville (1891)]. In the early twentirth century, two strands of studies (longitudinal [diary/case] studies and cross-sectional) evolved separately by linguists, educators, and psychologists (from the 1930s to 1950s in the study of child language acquisition which mainly studied phonological acquisition), and then merged.

Most of the studies initially were diary studies or case studies. The early *diary studies* were based on the parental notes of their children's speech development. The data for these studies were longitudinal, looking at the spontaneous speech collected in naturalistic settings and typically transcribed and analysed by a single individual. Studies by Stern & Stern (1907), Hills (1914), Hinkley (1915), Grégoire (1937), Velten (1943), and Leopold (1949) were all on parental diary studies. The most important study on phonological acquisition was Leopold's (1939-1949) study of his daughter Hildegard's language development from birth to tw years, where the study explains more about phonological acquisition and development. The more interesting thing in the study was that it studied the bilingual development (English and German) of the child. These studies documented the lists of early words of children with some indication of early word patterns and syllable shapes, the process like omissions and changes in the syllables and segments of child's utterances. They were carried out by individuals trained in linguistics and included sophisticated and detailed transcriptions of children's speech. Though they had obvious limitations to the diary study methods like objectivity, accuracy, and observer training, they provided some complete records of the individual children's early phonological development.

Educators and psychologists did group studies that wanted to set up norms for phonological acquisition in typically developing children to identify the atypical development in children. The studies conducted with the children in the US elicited productions of a list of single words that included nearly all the consonants of English that were the norms for children. The earliest major group studies of speech sound development appeared in the 1930s by collecting data using a cross-sectional study from a large group of children (Wellman, Case, Mengert & Bradbury, 1931; and Poole, 1934). These studies on the norm development had a very narrow focal point in documenting the acquisition of phonemes as sometimes only consonants of English were seen with a limited set of words.

Wellman et al. (1931) studied in the children in age group of two-six years the development of ability to correct the production of English sounds. Nevertheless, the goal of Templin's (1957) study was to illustrate the development of articulation of speech sounds from three to eight years. Templin's summary chart explains the expected age of phoneme acquisition for the English language.

Some studies employed different theoretical frameworks to examine phonological acquisition. Jakobson (1941, 1968) used the phonological theory of the Prague school. Stampe (1973) used Natural Phonology to study the phonological processes found, and Waterson (1971, 1987) used Firthian prosodic phonology to view how children can capture the perceptual feature from the words they hear and derive structural information or schemata to guide their productions. Smith (1973) used the framework of generative phonology developed by Noam Chomsky and Morris Halle (1968) in Sound Pattern of English.

The widely held studies in phonological acquisition from 1970 onwards have measured the phonological processes in child language acquisition and disorders. Ingram (1974, 1986) classifies these processes into three main types (Assimilation process, Substitution process, and Syllable Structure Simplification process), which have some subtypes. The term phonological processing is used to refer to the adjustments made in phonological rules (Menn, 1976; Smith, 1973; Oller, 1975; Ingram, 1979; Stampe 1969, 1973), proposing the theory of "Natural Phonology", which puts forward that children's early phonological systems are constrained by a set of natural phonological processes that represent the innate mental constraints on the child's productive abilities. Ferguson and Farwell (1975) examined the phonetic and phonological features of the first 50 words of three children.

Weiner (1979) also accounts for 16 different phonological processes. They are the deletion of final consonants, cluster reduction, weak syllable deletion, glottal replacement, stopping, fronting, gliding of fricatives, affrication, denasalization, gliding of liquids, vocalization, assimilation of various types viz., labial, alveolar, and velar, pre-vocalic and final consonant devoicing. Similarly, Shriberg and Kwiatkowski (1985) reported eight processes: final consonant deletion, velar fronting, stopping, palatal fronting, liquid simplification, assimilation of progressive and regressive type, cluster reduction, and unstressed syllable deletion.

Hodson (1980) classified the phonological processes into five types. Primary processes are Obstruent deviations, Sonorant deviations, Assimilation, Articulatory shifts, and various phonological processes, which have many sub-classifications.

Obstruent deviations are syllable reduction, cluster reduction, prevocalic obstruents, singleton omissions, post-vocalic obstruents, singleton omissions, stridency deletion, and velar deviations.

Sonorant deviations are the deviations in liquid /l/, liquids /r/, /δ/, nasals, glides, and vowels.

Assimilation that happens due to nasals, velars, labials, and alveolars.

Articulatory shifts include the substitution of /f/, /v/, /s/, /z/ for /θ/ frontal lisp, dentalization of /t/, /d/, /n/, /l/, and lateralization.

Some other miscellaneous phonological processes are prevocalic voicing, postvocalic devoicing, glottal replacement, backing, stopping, affrication, deaffrication, palatalization, depalatalization, coalescence, epenthesis, and metathesis.

Ingram (1981) has listed 27 processes and broadly classified them into eight categories. The categories are the Deletion of initial and final consonants; Reduction of a consonant cluster reduplication; Fronting of palatals and velars; stopping initial voiceless fricatives, initial voiced fricatives, and initial affricates; Simplification of liquids and nasals. Other substitution processes like deaffrication, apicalisation, labialization, and assimilatory processes include velar and labial assimilation, prevocalic voicing, and devoicing of the final consonant.

On the other hand, Dyson and Paden (1983) examined the elimination of five phonological processes by 40 two-year-old children. The processes observed were: gliding, cluster reduction, fronting, stopping, and final consonant deletion.

Stoel-Gammon and Cooper (1984) gathered data to observe and document patterns of early speech and language development, often about the development of the child's lexicon, and to explore the notion of universal patterns of acquisition using cross-linguistic data.

Smit et al. (1990, 1993) studied the sound speech production of 997 children aged three-nine years which was a large-scale cross-sectional study as the beginning of setting norms for phonological development. The study's findings felicitated clinicians and teachers with norms that provide the 'age of acquisition' of each phoneme of English. It also often guides the designing and implementation of intervention programmes for children with atypical speech sound development.

Seyhun (1997) studied the phonological rules in 22 typically developing Turkish-speaking children. Two of these children were observed longitudinally, and the remaining children aged between 1;3 – 3;0 were studied cross-sectionally. Data was obtained primarily by picture naming and spontaneous speech productions. The processes identified include; reduplication, syllable deletion, consonant deletion, assimilation, cluster reduction, liquid deviation, stopping, fronting, affrication, and backing.

Wolk and Meisler (1998) systematically compared two methods of speech elicitation, conversation, and picture naming, for phonological assessment. Subjects were 4;2 to 5;11-year-old, 13 English-speaking males who were phonologically impaired. The children's performances on a conventional speech task (CST) and 162 items picture-naming task (PNT) yielded similar sound error patterns and severity measures on the two tasks were highly correlated. However, subjects exhibited a higher percentage of occurrences of phonological processes in the naming procedure than in conversation.

J. Barlow and J. Gierut (1999) examined phonological acquisition using Optimality Theory and explained children's common error patterns, looked into Inter- and Intra child variation and effective change over time using the theory. The optimality theoretical perspective was used to analyse the error patterns of fronting, stopping, final consonant deletion, and cluster simplification.

Z. Hua and B. Dodd (2000) studied the phonological acquisition of 129 monolingual Putonghua-speaking children aged 1;6 to 4;6 years. This research viewed that children who speak Putonghua learned the elements of Putonghua syllables like tone, syllable-initial consonant, vowel, and syllable-final consonant. Simple vowels emerged early in development, but triphthongs and diphthongs were persuaded to error patterns. The study traced phonological processes like syllable-initial consonant deletion and backing, and errors in tone production were found to be rare. However, even older children did not ultimately acquire ‘weak stress’ and ‘rhotacized feature.’

Porter and Hodson (2001) studied the speech samples of 520 typically developing children between 2; 6 and 8; 0 (years; months). The main focus was on syllables and word structures. In this study, three-year-old children have acquired all the phoneme classes except liquids. By the age of 3, children have acquired strident phoneme class, but sibilant lisps were found until seven years. Older participants acquired /l/ between four and five years of age and /r/ between five and six years.

The study by Goldstein and Washington (2001) investigated phonological patterns in 12 typically developing four-year-old Spanish-English bilingual children. The study administered a single-word phonological assessment with distinct versions for English and Spanish to determine the phonetic inventory, percentage of correct consonants for voicing, place of articulation, the manner of articulation, and the percentage of incidence of phonological processes. The result shows no significant differences between the two languages.

N. Alias (2005) studied phonemic acquisition and phonological processes among three (3;06 to 3;11) years old Malay children to obtain the Malay language’s phonemic inventory and phonological processes. A picture naming test with 60 pictures that contain Malay phonemes in all three-word positions was used to collect samples from nine Malay children. All subjects have acquired Malay phonemes except /f, v, s, z, r/ by age of three; 83.8 per cent of the consonants in their speech correctly occurred; 52.2 per cent of the syllable structure processes, 40 per cent of the substitution process, 6 per cent of other processes, and 2 per cent of the assimilation processes were found.

Cohen and Anderson (2010) studied phonological processes in 94 preschool children’s single-word productions. They compared phonological processes present in children with published normative data relating to typical ages of elimination of phonological processes. These 94 children, grouped into four six-month age bands from 3;1 to 4;11 years, named 78 pictures. Their responses were broadly transcribed and then analyzed for phonological processes. Results indicated the presence of velar fronting, and stopping of affricates. However, there was a lower-than-expected incidence of palato-alveolar fronting, stopping of fricatives, and obstruent cluster reduction.

Phoon and Maclagan (2010) studied the phonological skills of 264 typically developing English-speaking Malaysian Chinese children between the ages of three to seven years. Speech samples were collected with 195 words, which sampled 24 Malaysian English consonants in various syllable positions. The study illustrates final consonant deletion, stopping of fricatives, the substitution of fricatives, fronting of fricatives, depalatalization, medial consonant devoicing, alveolarization, cluster creation, deaffrication, and affrication as major phonological processes in children. Other phonological processes, except final consonant deletion, fronting of fricatives, alveolarization, deaffrication, and affrication, were suppressed before the age of four.

Eman Mohammed Abdulrahman Abdoh (2010) studied the phonological structure and representation of first words in Hijazi Arabic. It investigated the representational nature of early words and the developmental stages of their syllable and internal word structure within the framework of the Prosodic Theory. It revealed the usage of phonological processes (e.g., reduplication, consonant harmony, substitution, truncation) when their templates could not accommodate all the segmental material of the target words.

Fernanda Marafiga Wiethan et al. (2014) verified the relationships between the lexical and phonological development of 18 children aged between one to two years old. The number of entirely and partially acquired sounds were counted together, and the 19 sounds and two allophones of Brazilian Portuguese were considered.

Shaima Alqattan (2015) explored the typical phonological development in the speech of 70 children acquiring Kuwaiti-Arabic before the age of four. The outcomes of this study provide essential knowledge about typical Arabic phonological development and the first step toward building a standardized phonological test for Arabic-speaking children.

### 3.1.1. *Phonological Acquisition in Indian Languages*

Very few studies have been conducted on phonological processes in Typically Developing Children in the Indian context. Although, several attempts to study phonological processes in typically developing children speaking various Indian languages aimed at systematically comparing phonological acquisition in children.

Thirumalai (1972) has described some aspects of the acquisition of Tamil phonology of a four and a half years old boy. The results indicated the child had acquired all stop consonants, nasal and laterals present in adult Tamil phonology by that time.

Bilingual language acquisition research in the Indian context includes few studies describing phonological acquisition in children acquiring two or more languages together. One study includes Balachandran and Nirmala (1978), which investigated substitution and assimilatory processes across three Indian languages (Tamil, Telugu, and Hindi). Substitution of nasals, fricatives, stops, laterals, affricates, flap/trill, voice assimilation, dental assimilation, vocal harmony, nasal harmony, nasalization, and devoicing of final consonants were found in all three languages. Out of 13 children of one to five years, one is Bilingual (Tamil- Telugu), four are Telugu, and eight are Hindi-speaking children.

Usha (1986) framed the Tamil Articulation Test to test articulation in the Tamil-speaking population. For the study, 180 Tamil-speaking, typically developing children of three-six years were selected, and segmental patterns were analysed regarding addition, substitution, distortion, and omission to set the norms for the test.

Vasanta (1990) formulated a Telugu Test of Articulation and Phonology (TTAP), entitled “Maximizing phonological information from a picture-word Telugu Articulation test,” where she emphasised the phonological processes analysis because of its informative details to plan remedial programmes than the traditional analysis procedures.

Sameer (1998) studied three-four-year-old 30 Malayalam-speaking children's phonological processes. Assessment using Malayalam Articulation Test revealed the persisting processes of final consonant deletion, apicalisation, affrication, and epenthesis. Decreasing processes found in the study were deaffrication, stopping, stridency deletion, fronting, reduplication, palatalization, atypical with reduction, medial consonant deletion, the backing of fricatives, denasalized and articulatory shifts.

Sunil (1998) conducted a study on three to four-year-old Kannada speaking typically developing children who revealed several phonological processes in their speech utterances, which tend to continue even after four years of age. Also, results indicated that, as age advanced to four years, phonological processes like medial consonant deletion, final consonant deletion, and affrication decreased, but some processes like fronting and cluster reductions persisted.

Jayashree (1999) used the Kannada Articulation Test to investigate the phonological processes of 30 Kannada-speaking children of four-five years. Results showed the cluster reduction, fronting, and stopping as persisting processes, whereas metathesis, epenthesis, prevocalic voicing, and palatalization were decreasing processes.

Lakshmi Bai (2000) detailed phonological acquisition in two Tamil-Telugu bilingual children. Her study is a systematic diary study of two children's speech development (Child 1: 11 months to 4.6 years and Child 2: 10 months to 4.8 years of age). The results showed that final consonant deletion, reduplication, cluster reduction, and syllable reduction were structure simplification processes. Assimilatory processes included voicing and consonant harmony followed by bilabial, velar, and nasal assimilations. The substitution processes found were stopping, fronting, gliding, and vocalization.

A study by Bharathy (2001) used Tamil Articulation Test (Usha, 1986) to study the phonological processes of three to four-year-old 30 Tamil-speaking children. The 15 processes found among children were initial consonant deletion, final consonant deletion, unstressed syllable deletion, cluster reduction, gliding, stopping of liquids, stopping of fricatives, nasal assimilation, voicing assimilation, metathesis, epenthesis, fronting, backing, deaffrication, and affrication. The study reveals that after three and a half years, final consonant deletion faded, and after three years nine months, initial consonant deletion, cluster reduction, unstressed syllable deletion, gliding, nasal assimilation, voicing assimilation, backing, epenthesis, deaffrication, and affrication declined markedly. Almost all the processes had been reduced by the end of four years, except epenthesis, cluster reduction, and stopping of liquids.

Roopa and Jayanthi (2004) studied the phonological patterns in a typically developing 23-month-old Kannada and English-speaking bilingual child. Spontaneous speech samples in both languages were collected between 23 and 29 months. Phonological processes in Kannada included flaps for retroflex sounds, dentalization of /s/ in word-final position, etc. Phonological processes evidenced in English included epenthesis, the addition of vowels in word-final positions in specific contexts, dental stops for interdental fricatives, labial stops for labiodentals fricatives, dentalization of /s/ in word-final position, vowelization, metathesis, etc.

Ranjan (2009) analysed phonological processes in Sixty English-speaking, Indian children of 3 to 4 years of age. Picture articulation test in English was used where 14 different phonological processes like cluster reduction, final consonant deletion, strident deletion, assimilation were found among three to four-year-old children, and 13 phonological processes were found among four to five-year-old children. The frequency of occurrence of phonological processes showed differences across the age groups.

Further, Venkatesh, Ramsankar, Nagaraja, and Pushpa Srinivasan (2010) investigated 60 Typically Developing Tamil-speaking children and Tamil-Telugu bilingual children aged four to six and a half years years. Results provided preliminary evidence for differences in children's phonological skills development.

Single-word utterances were elicited as naming responses to picture cards of the Test of Articulation in Tamil. The findings had implications for identifying any delay/deviance in phonological development in both groups.

Shailaja Shukla, Manjula and Praveen (2011) analysed and compared the time, space, and whole word patterns in the conversational speech of two to seven years old 50 Kannada speaking typically developing children. The order of acquisition of features among the whole word patterns was epenthesis, reduplication, syllable deletion, cluster reduction, and consonant deletion. Statistically, significant differences and a decreasing trend in the occurrence of total patterns with an increase in age were observed.

Prathamesh Bailoor, Maithily Rai, and Lavanya Krishnan (2014) studied the development of phonological processes in typically developing three to four-year-old Kannada- English Indian bilingual children and compared with that of monolingual Kannada-speaking children of same-age group. Data from spontaneous speech like general conversation, story narration, and picture description tasks had shown the occurrence of 14 phonological processes. The study accounted for fronting, initial consonant deletion, final consonant deletion, cluster reduction, epenthesis, metathesis, and affrication as the most common process and medial consonant deletion, the backing of stops, backing of fricatives, stopping, alveolar assimilation, and vowel un-rounding as the least.

Anitha, Shruthi, Rajalakshmi, Jenny, and Satish (2015) compared the phonological processes across urban and rural in the thirty typically developing Malayalam speaking three to four-year-old children. Using the Malayalam articulation test, speech samples were recorded using PRAAT software, which revealed similar phonological processes across groups with consonant deletion, weak syllable deletion, cluster reduction, fronting, gliding, aspiration, palatalization, nasal assimilation, and epenthesis. Further, they noted that rural children exhibited more phonological processes than the urban group.

Ravali and Arun (2016) describe the phonological processes of 180 typically developing Hindi-speaking children, 3;5 to 6;5 years old were grouped into six age groups with 30 children in each. A phonological test in Hindi was developed and administered to assess phonological processes. The results indicated a total of 24 processes to be occurring in children's speech. However, processes declined as the age increased.

Kala and Lalitha Raja (2016) studied the phonological processes in 2.6 years to 6 years old 30 typically developing Tamil-speaking children. Stimulus contains 160 meaningful di-syllabic and tri-syllabic words in a combination of eighteen consonants, ten vowels, and two diphthongs in initial, medial, and final positions were used to assess. Results revealed the occurrence of 37 phonological processes in which substitution processes showed the highest occurrence than other processes, and also, the occurrence of the process was found to decrease as there was an increase in age group processes.

The earlier research analysed the speech and language acquisition of the normative group regarding phonological patterns. Most of the studies found all three processes; Assimilatory processes, Syllable structure processes, and Substitution processes occur in children's earlier development. Phonological processes differed in the percentage of the processes according to different languages. Language-specific features play a significant role in determining the children's phonological development of a given language though universality also plays a significant role in phonological acquisition.

## 3.2. Universality in Phonology and Phonological Acquisition

Chomsky (1965) proposed an innate linguistic theory in his generative-transformational theory, where he assumes that the child is innately endowed with a language faculty. The innate capacity, in a sense, is the linguistic universals, according to him.

### 3.2.1. *Universals in Phonology*

Larry M. Hyman's (1999) description of universal in phonological systems depicts universals in segments, features, and syllables as;

***Universals in segments:***

Consonant Universal-1: Every phonological system has plosives.
Consonant Universal-2: Every phonological system contrasts phonemes [-cont] (+stops) with phonemes specified with a different feature.
Consonant Universal-3: Every phonological system contrasts phonemes for the place of articulation.
Consonant Universal-4: Every phonological system has coronal phonemes.
Vocalic Universal-1: Every phonological system contrasts at least two degrees of the aperture.
Vocalic Universal-2: Every phonological system has at least one front vowel and the palatal glide /y/.
Vocalic Universal-3: Every phonological system has at least one unrounded vowel.
Vocalic Universal-4: Every phonological system has at least one back vowel.
Vocalic Universal-5: A vowel system may be contrastive only for an aperture if its vowels acquire vowel color from neighboring consonants.

***Universals in features:***

According to the above segmental universals, every language then has universal features like ± consonantal, ± high, ± low, ± continuant, ± coronals, ± lax, ± tense, ± strident, ± sonorant, and ± voiced.

***Universals in syllables**:*

All languages have syllables with a vowel (V) as the nucleus and consonants (C) as onset and coda, where the nucleus is obligatory, and onset/coda is optional. The universal syllable pattern is (C) V(C).

So, according to Chomsky, children are born with the ability of these universals. Chomsky's view attracted the attention of linguists in phonological acquisition. It shifted the research focus from the order of acquisition and its universal aspects to other issues related to the children's abilities, underlying system, and role in language acquisition.

Also, Paul de Lacy (2010), who works with constraints in phonology, has two different proposals: (a) innateness and (b) constraint construction mechanisms that refer to phonology-external structures. The innateness view is that constraints are hard-wired into the brain (i.e., part of our genetic make-up). The 'hard-wired' idea comes in two versions. One is that each constraint is specified independently. Only those constraints that are hardwired into the brain exist in this version, so extrinsic limits on constraints boil down to genetics. The other version is that there are hard-wired algorithms that automatically generate constraints – 'constraint generators' (sometimes called 'schemas'). So the constraints in all languages are universal, which is innate, and language-specific constraints are to be learned.

Questions like the linguistic faculty's location Many cross-sectional and longitudinal studies have been carried out to provide a clear picture of language acquisition, show similarities and differences among languages, and look for language universals. Theories of the phonological acquisition have contributed to language acquisition which has addressed two major issues; the universal tendencies in children's phonological acquisition; and the role language-specific features play in influencing the phonological development in a given language.

### **3.2.2.** ***Universals in Phonological Acquisition***

Any researcher in child phonology will likely cite Jakobson's (1968) Child Language, Aphasia, and Phonological Universals. In his view, phonological inventories were acquired by repeated division of the phonological space into two-way contrasts. This acquisition pattern would first distinguish vowels from consonants, then the differences between low and high front vowels. Then for consonants, the second contrast was between nasal and oral stops. So, the order of acquisition was claimed by Jakobson to be universal.

Studies on the phonological acquisition with empirical literature emerged reporting longitudinal/cross-sectional data reports this universality.

Table 11. illustrates the acquisition of English (E) and Tamil (T) vowels (Edwards, 2003; Felicia Gironda& Renee Fabus, 2011; and present study).

Table 11. Acquisition of English and Tamil vowels according to the age of mastery

| **Vowel Sounds** | **Age of at Least 100% Mastery** |
|---|---|
| /ʌ/ | 2 (E), 1;8 (T) |
| /i/; /u/; /o/ | 2 to 3 (E), (T) |
| /ə/ | 3 to 6 (E), 4 to 5 (T) |
| /ɛ/; /ɑɪ/; /ɑ/; /ɑʊ/ | 3 (E), (T) |
| /ɪ/ | 3 to 4 (E), (T) |
| /æ/; /e/ | 3 to 5 (E), (T) |

Further, Children's speech sound development can be analysed in phonetic vs. phonemic acquisition, where 'phonetic' refers to speech sound production (articulatory/motor skills), and the term 'phonemic' relates to the usage of the speech sounds according to the organization of the speech sound system of a particular language. Most earlier studies in Western countries (Wellman et al., 1931; Poole, 1934; Templin, 1957; Prather et al., 1975 and Smit et al., 1990) have conducted phonemic analyses on consonants. The children's speech sound production in word contexts is examined regarding the degree of output accuracy and the percentage of kids in an age group who reached the level of precision in phoneme production. A comparison of previous studies reveals significant differences in the age of acquisition of the same sounds. In Western countries, the norms clinicians use are mainly based on the studies of several authors.

Table 12 depicts the acquisition of speech sounds given by various authors and present study (M.N. Hegde, 2007) (Cited in Felicia Gironda& Renee Fabus, 2011)

Table 12. Age levels of speech sound development from five major Western and Indian Studies

| Sounds | Wellman et al. (1931) | Poole (1934) | Templin (1957) | Prather et al. (1975) | Arlt & Goodban (1976) | Sounds | Banu, T (1977) (Kannada) | Usha, D (1986) (Tamil) | Padmaja (1988) (Telugu) | Banik, A (1988) (Bengali) | Kala and Laitha Raja (2016) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| m | 3 | 3;6 | 3 | 2 | 3 | m | 3 | 3 | 2;6 | 2;5 | 2 |
| n | 3 | 4;6 | 3 | 2 | 3 | n | 3 | 3 | 2;6 | 2;5 | 2 |
| h | 3 | 3;6 | 3 | 2 | 3 | h | + | + | 2;6 | 3 | |
| p | 4 | 3;6 | 3 | 2 | 3 | p | 3 | 3 | 2;6 | 2;5 | 2;5 |
| f | 3 | 5;6 | 3 | 2;4 | 3 | f | + | + | 2;9 | + | |
| w | 3 | 3;6 | 3 | 2;8 | 3 | | | | | | |
| b | 3 | 3;6 | + | 2;8 | 3 | b | 3 | 3 | 2;6 | 2;5 | 2;5 |
| ŋ | + | 4;6 | 3 | 2;8 | 3 | ŋ | + | + | + | 2;5 | 2;5 |
| j | 4 | 4;6 | 3;6 | 2;4 | + | j | 3 | 3 | 2;6 | 2;5 | 2;5 |
| k | 4 | 4;6 | 4 | 2;4 | 3 | k | 3 | 3 | 2;6 | 2;7 | 2;8 |
| g | 4 | 4;6 | 4 | 2;4 | 3 | g | 3 | 3 | 2;6 | 3 | 2;8 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| l | 4 | 6;6 | 6 | 3;4 | 4 | l | 3 | 3 | 2;6 | 3 | 3 |
| d | 5 | 4;6 | 6 | 3;4 | 4 | d | + | 3 | 2;6 | 3 | 3 |
| t | 5 | 4;6 | 6 | 2;8 | 3 | t | + | 3 | 2;6 | 3 | 2;8 |
| s | 5 | 7;6 | 4;6 | 3 | 4 | s | 3 | 3 | 3;3 | + | 3 |
| r | 5 | 7;6 | 4 | 3 | 5 | r | 4;6 | + | 3;9 | 4 | 3;5 |
| tʃ | 5 | 4;6 | + | 3;8 | 4 | c | 3;7 | 3 | 2;6 | 3 | 3;5 |
| v | 5 | 6;6 | 6 | 4 | 3;6 | v | + | 3 | 2;6 | + | 3 |
| z | 5 | 7;6 | 7 | 4 | 4 | ʈ | | | | | 4;3 |
| ʒ | 6 | 6;6 | 7 | 4 | 4 | ɟ | 3 | 3 | 2;6 | 3 | 3 |
| θ | + | 7;6 | 6 | 4 | 5 | θ | 3 | + | + | 3 | 3;5 |
| ʤ | + | 7 | 4 | 4 | + | ɻ | | | | | 5;6 |
| ʃ | + | 6;6 | 4;6 | 3;8 | 4;6 | ʃ | 5;1 | 6 | 3;6 | 3 | 4 |

Note: '+' indicates sound was not tested or reported.

## Chronology of phonological processes

Little research has been directed towards the age or age range at which the various processes are there in the speech of typically developing children. Some earlier research provides direction on commonly occurring phonological processes and the ages at which these will get solved (Grunwell, 1985, 1987; Roberts Burchinal and Footo, 1990; Dodd, Holm, Hua and Crosbie, 2003). Stampe (1969) proposed that learning the sound system involves suppressing some innate simplification processes. When these processes are reduced, the children develop more contrasts in their speech and finally acquires the complete set of sounds of the adult model.

Phonological process occurrence can be divided into two major categories: Processes that disappear by three years and persist beyond three years (Stoel-Gammon and Dunn, 1985).

Table 13. Shows age of disappearance and appearance of phonological processes

| **Processes disappearing by three years of age** | **Processes persisting after three years of age** |
|---|---|
| Unstressed syllable deletion | Cluster reduction |
| Final consonant deletion | Epenthesis |
| Doubling | Gliding |
| Diminutization | Vocalization |
| Velar fronting | Stopping |
| Consonant assimilation | Depalatalization |
| Reduplication | Final devoicing |
| Prevocalic voicing | |

Most phonological processes are seen during the typical acquisition of speech. The most widespread process seems to be unstressed syllable deletion, which is present in the speech of nearly all children. The disappearance of a process may occur gradually, with the application being restricted to fewer and fewer target phonemes or specific word phonemes. The phoneme /ʋ/ is particularly prone to be produced as stops for an extended period, often until the child is six years or older (Snow et al., 1963). Children typically outgrow and learn to produce the correct targets by eight years (Stoel-Gammon and Dunn, 1985).

Ingram (1976) identified the processes that characterized children's speech from one and a half years to four years and suggested the age norms at which these phonological processes appear and disappear. The phonological processes commonly seen below age three include:fFinal consonant deletion, syllable reduplication, fronting, final consonant devoicing, prevocalic voicing, and vocalization. The processes that persist for long beyond three are cluster reduction, unstressed syllable deletion, labial assimilation, fricative stopping and affricates, and liquid replacements (l/r).

Bernthal and Bankson (1990) accounted that three to four years old children and normal children established a few standard processes: final consonant deletion, cluster reduction, vocalization, stopping, and gliding of liquids. However, Roberts, Burchinal, and Footo (1990) used a standard articulation test to study the phonological development of 145 normal children in the age range of two-and-a-half to eight years and reported a marked decline in process usage with an increase in age.

Table 14. Indicates typical phonological processes and corresponding normative data

| **Process** | **Approximate age of suppression** |
|---|---|
| Cluster reduction | 4;0 years |
| Epenthesis | 4;0 years |
| Initial consonant deletion | 3;0 years |
| Gliding | 5 above |
| Stopping | 3;0-5;0 years |
| Velar fronting | 3;6 years |
| Vocalization | 5 above |
| Alveolar assimilation | 3;6 years |
| Nasal assimilation | 3;6 years |
| Velar assimilation | 3;6 years |
| Prevocalic voicing | 3;0 years |

Data from Bauman-Waengler (2007), Bernthal and Bankson (2004), Khan (1982), and Peria-Brooks and Hegde (2007) studies states that different phonological processes disappear at a different age. According to Bowen (1998), some phonological processes (gliding, stopping, cluster reduction, and weak syllable deletion) disappear within four to five years of age. Shipley and McAfee (2004) state that seven phonological processes (cluster reduction, epenthesis, gliding of liquids, vocalization, stopping, depalatalization, and word-final devoicing) exist after age three.

Speech-language therapists define phonological delay as the presence of phonological processes seen in younger children (Joffe and Pring, 2008). As the child matures and acquires normal phonological development, these processes should disappear and replaced by the adult form of sound production. When such a process does not disappear but continues appearing in a child's speech, he/she is said to have a phonological disorder. However, the pattern of process usage after the age of three years may help speech-language pathologists distinguish between normal and delayed or deviant speech developments. Other errors, such as backing, initial consonant deletion, vowel distortions, or atypical substitutions, may indicate disordered or abnormal development (Dodd, 2005).

**Phonological processing of typically developing Tamil children**

Kala and Lalitha Raja's study (2016) identified the phonological processes in two-and-a-half to six years old typically developing Tamil-speaking children**.** The investigation revealed that 37 phonological processes occurred most commonly in children between two-and-a-half and six years of age. Table 15 indicates a list of phonological processes found in Tamil children.

Table 15. Total number of Phonological processes identified among TD children

| **Syllable structure** | **Substitution** | **Assimilation** | **Vowel** |
|---|---|---|---|
| Initial consonant deletion | Bilabial backing | Nasalization | Vowel fronting |
| Medial consonant deletion | Dental fronting | Denasalization | Vowel backing |
| Final consonant deletion | Dental backing | Nasal assimilation | Vowel raising |
| Initial syllable deletion | Alveolar fronting | | Vowel lowering |
| Medial syllable deletion | Palatal fronting | | Vowel lengthening |
| Final syllable deletion | Palatal backing | | Vowel shortening |
| Metathesis | Velar fronting | | Diphthongization |
| | Retroflex fronting | | Monophthongization |
| | Retroflex backing | | Initial vowel deletion |
| | Liquid gliding | | Medial vowel deletion |
| | Liquid stopping | | Final diphthong deletion |
| | Stop liquiding | | |
| | Stop gliding | | |
| | Glide stopping | | |
| | Glide liquiding | | |

### 3.3.1. *Constraints in Phonological Acquisition*

As stated earlier, constraints are universal in optimality theory, which states that they are present in all languages and grammar. With two basic types of constraints, faithfulness constraints, and markedness constraints, the relative ranking of these constraints can be used to state the differences in the grammar, which specifies that all the grammars have the same constraints, but they are ranked in grammar–specific order

Properties of marked sound systems are determined by perceptual and phonetic characteristics and the frequency and distribution of sound properties within and across languages. Those structures that are more difficult to perceive or produce or have limited occurrence cross-linguistically are marked, for example, [ɻ] retroflex lateral approximant in Tamil. Specifically, fricatives, affricates, liquids, and consonant clusters are examples of marked properties of language, whereas vowels, glides, nasals, and stops are examples of unmarked properties of language. Many languages lack marked sounds or sequences, where marked structures typically are acquired relatively late by children and pose difficulty for second-language learners (Blevins, 1995; Eckman, 1984, 1985; Eckman, Moravcsik, and Wirth, 1983; Greenberg, 1978; Hawkins, 1987; Maddieson, 1984; Smit, Hand, Freilinger, Bernthal, & Bird, 1990). Tamil does not have fricatives, affricates, or word-initial consonant clusters as phonemes. However, the nativized Tamil words borrowed from Sanskrit and English have fricatives, affricates, and consonant clusters. The occurrence of marked structures in output forms results in a violation of markedness constraints. Thus, the word train pronounced as [treɪn] violates a markedness constraint called *COMPLEX ("no clusters"; McCarthy & Prince, 1995) due to the marked cluster [tr-]. Because of the conflicting nature of the two types of universal constraints, there is an antagonistic relationship between faithfulness and markedness constraints. If a grammar allows the sweep to surface as relatively unmarked [teɪn], violation of *COMPLEX is avoided; however, this violates the faithfulness constraint MAX, because /r/ is deleted.

The difference between the two grammars lies in the ranking of constraints. In the former grammar, the satisfaction of *COMPLEX is more important than the satisfaction of MAX, meaning that *COMPLEX outranks MAX. MAX is more important than *COMPLEX; thus, MAX outranks *COMPLEX. On the other hand, if different grammar forces train to surface as [treɪn], violation of the faithfulness constraint MAX is avoided (because no segments are deleted); however, the markedness constraint *COMPLEX is violated because of the marked [tr-] cluster.

The conflict between faithfulness and markedness leads to constraint violability. Specifically, every output violates some constraint. In any grammar, for any input representation, certain faithfulness constraints are violated while satisfying certain markedness constraints, and certain markedness constraints are violated while satisfying certain faithfulness constraints in determining the optimal output forms. Violations of lower-ranked constraints typically do not affect the selection of output forms, whereas violations of higher-ranked constraints always do. The phonological analysis aims to determine the specific ranking for a given sound system based on the production facts. In the case of developing grammar in a child's language, it is necessary to decide on what specific ranking of constraints yields both the children's correct and erred productions based on a reliable sample of speech.

### 3.3.2. *Constraints in Tamil Phonological Acquisition*

The phonological acquisition by Tamil children shows universal patterns of phonological processing and some markedness. The constraints of phonological development in Tamil have to be found out using OT.

#### 3.3.2.1. *Analysis of Error Patterns Using OT*

The error patterns of the typically developing group have been discussed here under various error patterns like; deletion, substitution, assimilation, metathesis, and cluster simplification. All those have their further sub-classifications like;

Deletion – segment (consonant, vowel, and diphthong) and syllable deletion

Substitution – backing, stopping, fronting, gliding, liquiding, height positioning, duration shift

Cluster simplification – Reduction, Epenthesis, Coalescence

**A. Deletion / Syllable Structure Processes**

Deletion happens in two levels in children's phonology. They are in terms of segments and syllables. These processes are termed **Syllable Structure Processes** in phonological processing.

**a. Segment deletion**

Consonant, vowel, or diphthong segment deletions occur in children's speech.

For example, /kɑmpu/ > /ɑmpu/ is seen as **initial consonant deletion**, /ɑkɑl/ > /ɑɑl/ is seen as **medial consonant deletion, /** ɑɳil/ > /ɑɳi/ is seen as **final consonant deletion,** /uʈ̪ɑʈu/ > /ʈ̪ɑʈu/ is seen as **initial vowel deletion,** and /ʋɑ:jmɑi/ > /ʋɑ:jm/ is seen as **final diphthong deletion,** in phonological process analysis. However, for this study, it is considered segment deletion under the utilization of OT.

The conflict between the markedness (*ONSET, *CODA, and *NUCLEUS) and faithfulness constraints (MAX) and their violability by different output forms is shown in the following constraint tableaus. These patterns reflect the ranking of the markedness constraint *ONSET ("no initial consonants") for /kɑmpu/ > /ɑmpu/ and /ɑkɑl/ > /ɑ.ɑl/, *CODA, ("no final consonants") for /ɑɳil/ > / ɑɳi/ and *NUCLEUS, ("no vowel/diphthong") for /uʈ̪ɑʈu/ > /ʈ̪ɑʈu/ and /ʋɑ:jmɑi/ > /ʋɑ:jm/ over the faithfulness constraint MAX ("no deletion").

**i. Initial Consonant Deletion**

Figures 8 and 9 show a simplified sample tableau demonstrating how optimality theory accounts for the pattern of initial consonant deletion.

The segment /k/ deleted in the following data is the onset of the first syllable of the word /kɑmpu/. So the markedness constraint is ONSET, and the faithfulness constraint is MAX.

**(8)** Initial voiceless velar consonant (k) is deleted in a word**.**

| /kɑm.pu/ ‘Stick’ | *ONSET | MAX |
|---|---|---|
| a. [kɑm.pu] | *! | |
| b.☞[ɑm.pu] | | * |

**(9)** Medial voiceless velar stop /k/ (Initial Consonant of second) syllable is deleted

| / ɑ.kɑl / ‘lamp’ | *ONSET | MAX |
|---|---|---|
| a. [ɑ.kɑl] | *! | |
| b. ☞[ɑ.ɑl] | | * |

Though the deleted consonant /k/ occurs in the middle of the word /ɑkɑl /, according to the syllable division, the word can be syllabicated as /ɑ.kɑl/. So the segment /k/ is deleted at the onset of the word’s second syllable. So the OT analysis for this utterance can be done like it has been done for the previous word. So, this pattern reflects the ranking of the markedness constraint *ONSET (“no initial consonants”) over the faithfulness constraint MAX (“no deletion”) as it happened in the previous example.

Tableaus 8 and 9 illustrate the conflict between *ONSET and MAX. In the grammar of adult speakers of Tamil, *ONSET is ranked relatively lower than MAX, meaning that initial consonants are allowed to occur by the grammar. The tableaus (8) and (9) show that initial consonants are prevented from occurring, as *ONSET is ranked higher than MAX.

The ranking of constraints is indicated in (10), where double right-angled brackets (“>>”) separate the two constraints. Specifically, in the tableau (10), the constraints are ranked across the top, from most important (on the left) to least significant (on the right). The markedness constraint *ONSET is the most important and ranked highest. In this case, *ONSET outranks the faithfulness constraint MAX.

**(10) Initial Consonant Deletion**

***ONSET:** Avoid onsets/initial consonants

**MAX:** Input segments that must correspond to the output segments. (No deletion.)

**Ranking: *ONSET >> MAX**

The input representation /kɑmpu/ and its meaning in English are shown in the upper-left cell of tableaus (8) and (9). Output candidates (a) and (b) are shown along the left side. Only two candidates are accounted for here: the faithful candidates (a) [kɑm.pu] and [ɑ.kɑl] and the unfaithful candidates (b) [ɑm.pu] and [ɑ.ɑl], in which the initial [k] is deleted. According to the theory, an infinite number of outputs are generated by GEN; but the two most appropriate candidates (the target and the child's utterance) are only considered.

Candidates (a) are faithful candidates because it is identical to the input. All segments in the input are also present in this output form: The input has not been altered in any way. This means that candidate (a) satisfies the faithfulness constraint MAX. The cell under the MAX column for the candidate (a) is left blank to indicate satisfaction with the MAX constraint. On the other hand, candidate (a) includes an initial consonant [k], which violates the higher-ranked markedness constraint *ONSET. An asterisk ("*") in the corresponding cell indicates the violation of that constraint. Candidate (b) does not violate *ONSET because it has no initial consonant: /k/ is deleted. Therefore, the cell is left blank under the *ONSET column for the candidate (b). Because /k/ is deleted, the candidates (b) violate the faithfulness constraint MAX. An asterisk indicates that violation in the corresponding cell.

Thus, both candidates violate one of the constraints; however, one violation is more severe than the other. A violation of higher-ranked constraints is always worse than a violation of lower-ranked constraints. Therefore, candidates' (a) violation of higher-ranked *ONSET is a fatal violation, and candidates' (b) violation of lower-ranked MAX is nonfatal (hence, the shading in the column for that constraint).

The fatal violation is indicated with the exclamation point

("!") and eliminates the candidate from being chosen as optimal by the grammar. Accordingly, candidates (b) are selected by the child's grammar as the optimal candidates (the form that the child produced), and this is shown by the manual indicator ("☞") to the left of candidates (b). In Tamil-speaking children's production, it appears that it is better to violate the faithfulness constraint MAX than to have a final consonant in the output. Thus, to account for initial consonant deletion, *ONSET must outrank MAX. The same method of tabulations and descriptions is followed for all the following error patterns, too, with a detailed account of analysis and interpretation.

### ii. Final Consonant Deletion

Tableau (11) demonstrates how optimality theory accounts for the pattern of final consonant deletion.

**(11)** Final voiced alveolar consonant /l/ is deleted in a word.

| /ɑɳil/ 'Squirrel' | ***CODA** | **MAX** |
|---|---|---|
| a. [ɑɳil] | *! | |
| b. ☞[ɑɳi] | | * |

Tableau 11 illustrates the conflict between *CODA and MAX. In the grammar of adult speakers of Tamil, *CODA is ranked relatively lower than MAX, meaning that final consonants are allowed to occur by the child's grammar. However, a ranking such as that in the tableau in Figure 11 prevents final consonants from occurring, as *CODA is ranked higher than MAX. In this case, *CODA outranks the faithfulness constraint MAX. The ranking of constraints is indicated in (12).

**(12) Final Consonant Deletion**

***CODA:** Avoid codas/final consonants of the syllables
**MAX:** Input segments that must correspond to the output segments. (No deletion.)
**Ranking: *CODA>> MAX**

Here, the candidate (a) satisfies the faithfulness constraint MAX. On the other hand, candidate (a) includes a final consonant [l], which is a violation of the higher-ranked markedness constraint *CODA. Candidate (b) does not violate *CODA because it has no final consonant. i.e., /l/ is deleted.

Therefore, candidate(a)'s a violation of higher-ranked *CODA is a fatal violation which eliminates the candidate from being chosen as optimal by the child's grammar, and candidate(b)'s violation of lower-ranked MAX is nonfatal is selected by the child's grammar as the optimal candidate. Thus, to account for final consonant deletion, *CODA must outrank MAX.

**iii. Nucleus Deletion (Vowel and Diphthong)**

Tableaus (13) and (14) demonstrate how optimality theory accounts for the pattern of the nucleus (both vowel and diphthong) deletion.

**(13)** Deletion of initial back rounded short vowel /u/ in a word **(Initial Vowel Deletion).**

| /uʈ̺ɑʈu/ 'lip' | ***NUCLEUS** | **MAX** |
|---|---|---|
| a. [uʈ̺ɑʈu] | *! | |
| b. ☞ [ʈ̺ɑʈu] | | * |

**(14)** Deletion of final diphthong /ɑi/ in a word **(Final Diphthong Deletion).**

| /ʋɑ:jmɑi/ 'truth' | ***NUCLEUS** | **MAX** |
|---|---|---|
| a. [ʋɑ:jmɑi] | *! | |
| b. ☞ [ʋɑ:jm] | | * |

Tableaus (13) and (14) illustrate the conflict between *NUCLEUS and MAX. In the grammars of adult speakers of Tamil, *NUCLEUS is ranked relatively lower than MAX, meaning that vowels in the syllables are essential/obligatory to occur as per the grammar. But, a ranking in Figures 13 and 14 prevents the nucleus from occurring, so *NUCLEUS is ranked higher than MAX. In this case, *NUCLEUS outranks the faithfulness constraint MAX. The ranking of constraints is indicated in Tableau (15).

**(15) Vowel/Diphthong Deletion**

***NUCLEUS:** Avoid nucleus/diphthongs.
**MAX:** Input segments must correspond to the output segments. (No deletion.)
**Ranking: *NUCLEUS >> MAX**

Here, candidate (a) satisfies the faithfulness constraint MAX. Candidate (a) include nucleus [vowel ‘u’ and diphthong ‘ɑi’], where higher-ranked markedness constraint *NUCLEUS is violated. On the other hand, Candidates (b) do not violate *NUCLEUS because it has the deletion of vowel or diphthong. /u/ and / ɑi/ is deleted.

Therefore, candidate(a)s’ violation of higher-ranked *NUCLEUS is a fatal violation which eliminates the candidates from being chosen as optimal by the child’s grammar, and candidate(b) s’ violation of lower-ranked MAX is nonfatal is chosen by the child’s grammar as the optimal candidate. Thus, to account for vowel/diphthong deletion, *NUCLEUS must outrank MAX.

### b. Syllable Deletion

Syllable deletions that occur in children’s speech, such as /muʈʈɑi/ > /ʈʈɑi/ is, seen as **initial syllable deletion**, /e.ru.mɑi/ > /e.mɑi/ is seen as **medial syllable deletion,** /uɳɑʋu/ > /uɳɑ/, /pɑɳɑm/ > /pɑɳ/, and /kɑ:kiʈ̪ɑm/ > /kɑ:ki/ is seen as **final syllable deletion** in phonological process analysis. However, this study considers it under syllable deletion under the utilization of OT. Where ever the syllable deletion happens (in the initial, medial, or final position of the word), the constraints are based on the deletion of the nucleus along with onset/coda or onset and coda.

#### i. Initial syllable deletion

**(16)** Initial syllable /mu/ is deleted in the word ‘muʈʈɑi’, which is Initial syllable deletion.

| /muʈ.ʈɑi/ 'egg' | *NUCLEUS | *ONSET | MAX |
|---|---|---|---|
| a. [muʈ.ʈɑi] | *! | * | |
| b. ☞ [ʈ.ʈɑi] | | | ** |

In the case of initial-syllable deletion, the target word with the syllable structure of the shape 'CVC.CVV,' such as /muʈʈɑi/ "egg," is realized as marked C.CVV structure, as in [ʈ.ʈɑi]. The initial syllable /mu/ will not surface if a child's grammar has a high-ranked markedness constraint against 'CVC.CVV' syllables.

**(17)** Medial syllable /ɾu/ is deleted in the word eɾumɑi **(Medial syllable deletion)**.

| / e.ru.mɑi / 'buffalo' | *NUCLEUS | *ONSET | MAX |
|---|---|---|---|
| a. [e.ru.mɑi] | *! | * | |
| b. ☞ [e.mɑi] | | | ** |

In the case of medial-syllable deletion, the target word with the syllable structure of the shape 'V.CV.CVV,' such as / eɾumɑi / "Buffalo," is realized as marked 'V.CVV' structure, as in [emɑi]. The medial syllable /ɾu/ will not surface if a child's grammar has a high-ranked markedness constraint against 'V.CV.CVV' syllables.

These constraints, *ONSET and *NUCLEUS prohibit syllables in a word that opens with consonants, as in (18). *NUCLEUS and *ONSET, markedness constraints must be ranked higher than MAX, the faithfulness constraint, which requires that all segments from the input surface the output. In this grammar, since *NUCLEUS and *ONSET are ranked higher than MAX, it is better for a word to surface for the syllables to be parsed. The ranking of constraints is indicated in (18).

**(18) Syllable deletion**

***ONSET:** Avoid onsets/initial consonants of the syllables.
***NUCLEUS:** Avoid vowels/diphthongs.
**MAX:** Input segments that must correspond to the output segments. (No deletion.)
**Ranking**: *NUCLEUS, *ONSET >> MAX

A fatal violation of *NUCLEUS, *ONSET by the faithful Candidates (a) allows for the unfaithful Candidates (b) to surface with /ʈʈɑi/ and /emɑi / unparsed. The tableaux (16, 17) show this relationship for the target words /muʈʈɑi/ and /erumɑi/. Thus, to account for final syllable deletion, *NUCLEUS and *ONSET must outrank MAX.

### ii. Final syllable deletion

In the case of final-syllable deletion, target words with the syllable structure of the shape; 'V.CV.CV' such as /uɳɑʋu/ "food" is realized as marked 'V.CV' structure, as in [uɳɑ]; 'CV.CVC' such as /pɑɳɑm/ "money" is realized as marked 'CV.C' structure, as in [pɑɳ]; and 'CVV.CV.CVC,' such as /kɑɑkit̪ɑm/ "paper" is realized as marked 'CVV.CV' structure, as in [kɑɑki]. The final syllables / ʋu/, /ɑm/ and /t̪ɑm/ will not surface if a child's grammar has a high ranked markedness constraint against 'V.CV.CV,' 'CV.CVC,' and 'CVV.CV.CVC' syllables.

**(19)** Final syllable /ʋu/ is deleted in the word /uɳɑʋu/ **(Final syllable deletion)**.

| /u.ɳɑ.ʋu/ 'food.' | ***NUCLEUS** | ***ONSET** | **MAX** |
|---|---|---|---|
| a. [u.ɳɑ.ʋu] | *! | * | |
| b. ☞ [u.ɳɑ] | | | ** |

***NUCLEUS, *ONSET >> MAX**

**(20)** Final syllable /ɑm/ is deleted in the word /pɑɳɑm/ **(Final syllable deletion)**.

| /pɑɳ.ɑm/ 'money' | ***NUCLEUS** | ***CODA** | **MAX** |
|---|---|---|---|
| a. [pɑɳ.ɑm] | *! | * | |
| b. ☞ [pɑɳ] | | | ** |

***NUCLEUS, *CODA >> MAX**

**(21)** Final syllable /t̪ɑm/ is deleted in the words /kɑɑkit̪ɑm/ **(Final syllable deletion)**.

| / kɑɑ.ki.t̪ɑm / 'paper' | ***NUCLEUS** | ***ONSET** | *CODA | MAX |
|---|---|---|---|---|
| a. [kɑɑ.ki.t̪ɑm] | *! | * | * | |
| b. ☞[kɑɑ.ki] | | | | *** |

***NUCLEUS, *ONSET, *CODA >> MAX**

These constraints, *ONSET, and *NUCLEUS; *NUCLEUS and *CODA; *ONSET, *CODA, and *NUCLEUS prohibit syllables in a word-final position in (22). The markedness constraints, *NUCLEUS, *ONSET, and *CODA, must be ranked higher than MAX; the faithfulness constraint requires that all input segments surface in the output. In this grammar, because *NUCLEUS, *ONSET, and *CODA are ranked higher than MAX, the word should surface for the syllables to be parsed.

**(22) Syllable deletion**

> ***ONSET:** Avoid onsets/initial consonants of the syllables.
> ***NUCLEUS:** Avoid vowels/diphthongs.
> ***CODA:** Avoid codas/final consonants of the syllables.
> **MAX:** Input segments must correspond to the output segments. (No deletion.)
> **Ranking**: ***NUCLEUS, *ONSET >> MAX**

The tableaus (19), (20) and (21) shows this relationship for the target word /uɳɑʋu/, /pɑɳɑm/, and /kɑɑkit̪ɑm/. A fatal violation of constraints, *ONSET and *NUCLEUS; *NUCLEUS and *CODA; *ONSET, *CODA and *NUCLEUS by the faithful Candidates (a) allows for the unfaithful Candidates (b) to surface with /uɳɑ/, / pɑɳ/, and /kɑɑki/ unparsed. Thus, to account for final syllable deletion, *NUCLEUS, *CODA, *ONSET must outrank MAX.

## B. Substitution Processes

### a. Backing

In a pattern of backing, labial segment /p/ is replaced by coronal /t̪/ as in /peɳ/ > /t̪eɳ/ (Bilabial backing); coronal segments like / t̪/ and /ʈ/ are replaced by dorsal /ʈ/ and /k/as in /u:t̪ɑl/ > /u:ʈɑl/

(Dental backing) and /miʈʈɑ:j/ > /mikkɑ:j/ (Retroflex backing); dorsal-palatal /c/ is replaced by dorsal-velar /k/ as in /i:cɑl / > /i:kal/ (Palatal backing); and front vowel /i/ is replaced by back vowel /u/ as in /ɑ:ppiɭ/ > /ɑ:ppuɭ/ (Vowel backing)

An OT account of these error patterns would require proposing high-ranking markedness constraints, *LABIAL; *CORONAL - RETROFLEX; *CORONAL - DENTAL; *DORSAL - PALATAL; and *ANTERIOR as in (23). These constraints would be ranked above a faithfulness constraint, IDENT-PLACE, and entails that the input segments straightly resemble the output segments. In this case, IDENT-PLACE ensures that the place of articulation in the input is also preserved in the output.

**(23) Backing process**

***LABIAL:** Avoid labial segments
***CORONAL- RETROFLEX:** Avoid coronal segments
***CORONAL - DENTAL:** Avoid dorsal segments
***DORSAL - PALATAL:** Avoid dorsal segments
***ANTERIOR:** Avoid posterior segments.
**IDENT-PLACE:** Preserve place features from input segments.
**Ranking: *LABIAL, *CORONAL-RETROFLEX, *CORONAL-DENTAL, *DORSAL-PALATAL, *ANTERIOR >> IDENT-PLACE**

Backing happens in both vowel and consonants, and also in the same constraints like DORSAL – PALATAL changes into DORSAL – VELAR and CORONAL - DENTAL changes into CORONAL – RETROFLEX as in /i:cɑl / > / i:kal/ and //u:t̪ɑl/ > /u:ʈɑl/. The tableaux (24, 25, 26, 27, and 28) describe the change in place of the segments in these words.

**(24)** Bilabial stop voiceless consonant /p/ is changed as voiceless dental stop /t̪/ in **(Bilabial backing)**

| / peɳ / 'lady' | ***LABIAL** | **IDENT-PLACE** |
|---|---|---|
| a. [peɳ] | *! | |
| b. ☞ [t̪eɳ] | | * |

***LABIAL >> IDENT-PLACE**

**(25)** Voiceless retroflex stop /ʈ/ changed as voiceless velar stop /k/ **(Retroflex backing)**

| / miʈʈɑ:j/ 'sweet' | *CORONAL- RETROFLEX | IDENT-PLACE |
|---|---|---|
| a. [miʈʈɑ:j] | *! | |
| b. ☞[mikkɑ:j] | | * |

***CORONAL- RETROFLEX >> IDENT-PLACE**

**(26)** Voiceless dental stop /t̪/ changed as voiceless retroflex stop/ʈ/ **(Dental backing)**

| /u:t̪ɑl/ 'whistle' | *CORONAL - DENTAL | IDENT-PLACE |
|---|---|---|
| a. [u:t̪ɑl] | *! | |
| b. ☞ [u:ʈɑl] | | * |

***CORONAL - DENTAL >> IDENT-PLACE**

**(27)** Voiceless palatal stop /c/ changed as voiceless velar stop /k/ (**Palatal backing)**

| / i:cɑl/ | *DORSAL - PALATAL | IDENT-PLACE |
|---|---|---|
| a. [i:cɑl] | *! | |
| b. ☞[i:ka] | | * |

***DORSAL - PALATAL >> IDENT-PLACE**

**(28)** Front unrounded short vowel /i/ changed as back rounded short vowel /u/ **(Vowel backing)**

| / ɑ:ppiɭ / | *ANTERIOR | IDENT-PLACE |
|---|---|---|
| a. [ɑ:ppiɭ] | *! | |
| b. ☞[ɑ:ppuɭ] | | * |

***ANTERIOR >> IDENT-PLACE**

The tableaus (24, 25, 26, 27, and 28) illustrate these relationships for the target words /peɳ/, /miʈʈɑ:j/, /u:t̪ɑl/, /i:cɑl/, and /ɑ:ppiɭ/. By ranking, *LABIAL; *CORONAL- RETROFLEX; *CORONAL - DENTAL; *DORSAL - PALATAL; and *ANTERIOR above IDENT-PLACE, the grammar ensures that the less marked form, Candidates (b), will be the optimal output. Candidates (a), the faithful, target-appropriate output form for input /peɳ/, /miʈʈɑ:j/, /u:t̪ɑl/, /i:cɑl/, and /ɑ:ppiɭ/, incurs a fatal violation of *LABIAL; *CORONAL- RETROFLEX; *CORONAL - DENTAL; *DORSAL - PALATAL; and *ANTERIOR above IDENT-PLACE, because a labial segment [p], coronal segment [ʈ], coronal-dental segment [t̪], dorsal palatal segment [c], and anterior-vowel segment [i] are in those output forms.

These candidates, however, satisfy IDENT-PLACE because all the output segments retain the same place of articulation as their corresponding input segments. Candidates (b), on the other hand, satisfy *LABIAL; *CORONAL- RETROFLEX; *CORONAL - DENTAL; *DORSAL - PALATAL; and *ANTERIOR above IDENT-PLACE, because there is no labial segment [p], coronal segment [ʈ], coronal-dental segment [t̪], dorsal palatal segment [c] and anterior-vowel segment [i] in the candidate forms. Yet these candidates do violate IDENT-PLACE because (i) the labial segment [p] corresponds to the coronal-dental segment [t̪], (ii) coronal - retroflex segment [ʈ] corresponds to the dorsal velar segment [k], (iii) coronal-dental segment [t̪] corresponds to coronal-retroflex segment [ʈ], (iv) dorsal palatal segment [c] corresponds to dorsal velar segment [k] and (v) anterior-vowel segment [i] corresponds to posterior-vowel segment [u] in the output. Because LABIAL; *CORONAL- RETROFLEX; *CORONAL - DENTAL; *DORSAL - PALATAL; and *ANTERIOR are ranked higher than IDENT-PLACE, a violation of the higher ranked constraints are considered fatal. This leaves Candidates (b) as the more harmonic candidates, and the child grammar chooses /t̪eɳ/, /mikkɑ:j/, /uʈɑʈu/, /i:kal/, /ɑ:ppuɭ/ as the optimal forms, despite their violation of lower ranked IDENT-PLACE.

Thus, for the children who present a pattern of backing, it is more important that labial; coronal- retroflex; coronal - dental;

dorsal - palatal; and anterior be prevented from surfacing than it is for an underlying place of articulation to be preserved. This prevention reflects the relatively marked status of labial; coronal-retroflex; coronal - dental; dorsal - palatal; and anterior place in the acquisition and illustrates the ranking relationship of markedness over faithfulness constraints in children's grammars.

### a. Fronting

In a pattern of fronting, (i) palatal segment /c/ is replaced by dental /t̪/ ; (ii) velar segment /k/ is replaced by dental /t̪/; (iii) retroflex segment /ʈ/ is replaced by dental /t̪/; (iv) alveolar segment /n/ is replaced by labial /m/; and (v) posterior vowel segment /u:/ is replaced by anterior vowel segment /i:/ are respectively, as in /ci:ppu/ > /t̪i:ppu/ (**Palatal fronting);** /kɑ:ʈu/ > /t̪ɑ:ʈu/ **(Velar fronting);** /miʈʈɑ:j/ **>**/mit̪t̪ɑ:j/ **(Retroflex fronting);** /orrɑn/ > /orrɑm/ (**Alveolar fronting);** and /u:mɑi/ > /i:mɑi/ **(Vowel fronting)**.

An OT account of this error pattern would require proposing for the high-ranking markedness constraints, *DORSAL – PALATAL; *DORSAL - VELAR; *CORONAL - RETROFLEX; *CORONAL - ALVEOLAR; and *POSTERIOR, as in (29). These constraints would be ranked above a faithfulness constraint, IDENT-PLACE, which entails that the input representation straightly resembles the output representation. In this case, IDENT-PLACE ensures that the place of articulation in the input is also preserved in the output.

**(29) Fronting Process**

***DORSAL – PALATAL:** Avoid dorsal-palatal segments.
***DORSAL – VELAR:** Avoid dorsal-velar segments.
***CORONAL – RETROFLEX:** Avoid dorsal segments.
***CORONAL – ALVEOLAR:** Avoid dorsal segments.
***POSTERIOR:** Avoid dorsal segments.
**IDENT-PLACE:** Preserve place features in the input segments.
**Ranking: *DORSAL-PALATAL, *DORSAL-VELAR, *CORONAL-RETROFLEX, *CORONAL-ALVEOLAR, *POSTERIOR >> IDENT-PLACE**

Fronting happens in both vowel and consonants, and also in the same constraints like CORONAL – RETROFLEX changes into CORONAL - DENTAL as in /miʈʈɑ:j/> /mit̪t̪ɑ:j/. The tableaus (30, 31, 32, 33, and 34) give the description of the change in place of the segments in these words.

**(30)** Voiceless palatal stop /c/ changed as voiceless dental stop /t̪/ (**Palatal fronting)**

| /ci:ppu/ 'comb' | *DORSAL– PALATAL | IDENT-PLACE |
|---|---|---|
| a. [ci:ppu] | *! | |
| b. ☞ [t̪i:ppu] | | * |

***DORSAL – PALATAL >> IDENT-PLACE**

**(31)** Voiceless velar stop/k/ changed as voiceless dental stop /t̪ / **(Velar fronting)**

| / kɑ:ʈu / 'forest' | *DORSAL– VELAR | IDENT-PLACE |
|---|---|---|
| a. [kɑ:ʈu] | *! | |
| b. ☞ [t̪ɑ:ʈu] | | * |

***DORSAL – VELAR >> IDENT-PLACE**

**(32)** Voiceless retroflex stop /ʈ/ changed as voiceless dental stop / t̪ / (**Retroflex fronting)**

| / miʈʈɑ:j / 'sweet' | CORONAL– RETROFLEX | IDENT-PLACE |
|---|---|---|
| a. [miʈʈɑ:j] | *! | |
| b. ☞ [mit̪t̪ɑ:j] | | * |

***CORONAL – RETROFLEX >> IDENT-PLACE**

**(33)** Voiced alveolar nasal /n/ changed as voiced bilabial nasal /m/ (**Alveolar fronting)**

| /orran/ 'spy' | CORONAL– ALVEOLAR | IDENT-PLACE |
|---|---|---|
| a. [orran] | *! | |
| b.☞ [orram] | | * |

***CORONAL – ALVEOLAR >> IDENT-PLACE**

**(34)** Back rounded long vowel /u:/ changed as front unrounded long vowel /i:/ (**Vowel fronting)**

| /u:mɑi/ 'dumb' | **POSTERIOR** | **IDENT-PLACE** |
|---|---|---|
| a. [u:mɑi] | *! | |
| b. ☞ [i:mɑi] | | * |

***POSTERIOR >> IDENT-PLACE**

The tableaus (30, 31, 32, 33 and 34) illustrate these relationships for the target words /ci:ppu/, /kɑ:t̪u/, /miʈʈɑ:j/, /orrɑn/, and /u:mɑi/. By ranking *DORSAL-PALATAL; *DORSAL-VELAR; *CORONAL-RETROFLEX; *CORONAL-ALVEOLAR; and *POSTERIOR; above IDENT-PLACE, the grammar ensures that the less marked form, Candidates (b), will be the optimal output. Candidates (a), the faithful, target-appropriate output form for input /ci:ppu/, /kɑ:ʈu/, /miʈʈɑ:j/, /orrɑn/, and /u:mɑi/, incurs a fatal violation of *DORSAL – PALATAL; *DORSAL – VELAR; *CORONAL – RETROFLEX ; *CORONAL – ALVEOLAR; *POSTERIOR above IDENT-PLACE, because palatal segment [c], dorsal segment [k], coronal-retroflex segment [ʈ], coronal palatal segment [n] and posterior-vowel segment [u] are in those output forms.

These candidates, however, satisfy IDENT-PLACE because all the output segments retain the same place of articulation as their corresponding input segments. Candidates (b), on the other hand, satisfy *DORSAL – PALATAL; *DORSAL – VELAR; *CORONAL – RETROFLEX ; *CORONAL – ALVEOLAR; *POSTERIOR above IDENT-PLACE, because there is no dorsal-palatal segment [c], dorsal-velar segment [k], coronal-retroflex segment [ʈ], coronal-alveolar nasal segment [n] and posterior-vowel segment [u] in the candidate forms. Yet these candidates do violate IDENT-PLACE because (i) the palatal segment [c] corresponds to coronal-dental segment [t̪], (ii) dorsal segment [k] corresponds to coronal-dental segment [t̪], (iii) coronal-retroflex segment [ʈ] corresponds to coronal-dental segment [t̪], (iv) coronal –alveolar nasal segment [n] corresponds to labial nasal segment [m], and (v) posterior-vowel segment [u] of the input corresponds to anterior-vowel segment [i] in the output. Because *DORSAL – PALATAL; *DORSAL – VELAR; *CORONAL – RETROFLEX; *CORONAL – ALVEOLAR; *POSTERIOR are ranked higher than IDENT-PLACE, a violation of the higher ranked constraints are considered fatal. This leaves Candidates (b) as the more harmonic candidates, and the grammar chooses /t̪i:ppu/, /t̪ɑ:ʈu/, /mit̪t̪ɑ:j/, /orrɑm/, and /i:mɑi/ as the optimal forms, despite their violation of lower ranked IDENT-PLACE.

Thus, for the children who present a pattern of fronting, it is more important that dorsal–palatal; dorsal–velar; coronal – retroflex; coronal – alveolar; posterior be prevented from surfacing than it is for an underlying place of articulation to be preserved. This prevention reflects the relatively marked status of dorsal–palatal; dorsal – velar; coronal – retroflex; coronal – alveolar; posterior place in the acquisition and illustrates the ranking relationship of markedness over faithfulness constraints in children's grammars.

### c. Gliding

Children exhibit two gliding patterns, evident in their productions of /n̪u:ru/ > /n̪u:ju/ (**Liquid gliding)** and /ceʈi/ > /ceji/ (**Stop gliding).** To account for children's gliding pattern, it is assumed that *LIQUIDS ("no liquids") and *STOPS ("no stops") outranks IDENT- CONSONANTAL ("don't change [consonantal]"), as in (35) below. Accordingly, it is a worse violation of Children's grammar for a liquid and a stop, such as [r] and [ʈ], to surface in the output than it is to change the [consonantal] feature of a liquid in the input.

**(35) Gliding**

***LIQUIDS:** Avoid liquids
***STOPS:** Avoid stops
**IDENT- CONSONANTAL:** Preserve consonantal features in the input segments.
**Ranking: *LIQUIDS >> IDENT- CONSONANTAL**
***STOPS >> IDENT- CONSONANTAL**

Gliding happens in consonants, like *LIQUIDS and *STOPS changes into glides as in /n̪u:ru/ > /n̪u:ju/ and /ceʈi/ > /ceji/. The tableaux (36 and 37) give the description of the change in manner of the segments in these words.

**(36)** Voiced alveolar trill /r/ changed as voiced palatal approximant /j/ (**Liquid gliding)**

| / n̪u:ru / 'hundred' | ***LIQUIDS** | **IDENT-CONSONANTAL** |
|---|---|---|
| a. [n̪u:ru] | *! | |
| b. ☞[n̪u:ju] | | * |

***LIQUIDS >> IDENT – CONSONANTAL**

**(37)** Voiceless retroflex stop /ʈ/ changed as voiced palatal approximant /j/ **(Stop gliding)**

| / ceʈi / 'plant' | ***STOPS** | **IDENT-CONSONANTAL** |
|---|---|---|
| a. [ceʈi] | *! | |
| b. ☞ [ceji] | | * |

***STOPS >> IDENT- CONSONANTAL**

These rankings described in (35) are further illustrated in tableaus 36 and 37. For the words /n̪u:ru/ and /ceʈi/, two possible output candidates are considered: the faithful candidates (a) [n̪u:ru] and [ceʈi] and the unfaithful candidates (b) [n̪u:ju] and [ceji]. As with previous examples, the unfaithful candidates (b) are the output preferred by children's grammar due to the higher ranking markedness constraints *LIQUIDS and *STOPS. Thus, to account for the gliding pattern, *LIQUIDS and *STOPS must outrank IDENT- CONSONANTAL.

For all examples of gliding, it is assumed that a violation of IDENT- CONSONANTAL ("don't change consonants") is incurred because the major class feature [consonantal] is changed. Gliding involves a change in [consonantal]; nevertheless, [consonantal] is the contrast between glides and liquids/stops.

### d. Liquiding

Children exhibit two liquiding patterns, evident in their productions of /ɑːʈu / > /ɑːru/ **(Stop liquiding)** and /ɑʋɑɾɑi / > /ɑlɑɾɑi/ (**glide liquiding).** To account for children's liquiding pattern, it is assumed that *STOPS ("no stops") and *GLIDES ("no glides") outranks IDENT- MANNER ("do not change [MANNER]"), as in (38) below. Accordingly, it is a worse violation of Children's grammar for a stop and a glide such as [ʈ] and [ʋ] to surface in the output than it is to change the [MANNER] feature of a stop and glide into liquid in the input.

**(38) Liquiding**

> ***STOPS:** Avoid stops
> ***GLIDES:** Avoid glides
> **IDENT- MANNER:** Preserve the manner features of input segments.
> **Ranking:**
> ***STOPS >> IDENT- MANNER**
> ***GLIDES >> IDENT- MANNER**

Liquiding happens in segments, like *GLIDES and *STOPS. Here glides and stops changes into liquids as in /ɑːʈu/ > /ɑːru/ and /ɑʋɑɾɑi / > /ɑlɑɾɑi/. The tableaus (39 and 40) give the description of the change in the manner of the segments in these words.

**(39)** Voiceless retroflex stop /ʈ/ changed as voiced alveolar trill /r/ **(Stop liquiding)**.

| /ɑːʈu/ 'goat' | ***STOPS** | **IDENT-MANNER** |
|---|---|---|
| a. [ɑːʈu] | *! | |
| b. ☞ [ɑːru] | | * |

***STOPS >> IDENT-MANNER**

**(40)** Voiced labio-dental approximant /ʋ/ changed as voiced alveolar lateral approximant /l/ **(Glide liquiding)**.

| /ɑʋɑɾɑi/ ‘Indian bean’ | ***GLIDES** | **IDENT-MANNER** |
|---|---|---|
| a. [ɑʋɑɾɑi] | *! | |
| b. ☞ [ɑlɑɾɑi] | | * |

***GLIDES >> IDENT- MANNER**

The ranking in (38) is illustrated in tableaus (39) and (40). For the words /ɑ:ʈu/ and /ɑʋɑɾɑi/, two possible output candidates are considered: the faithful candidates (a) [ɑ:ʈu] and [ɑʋɑɾɑi] and the unfaithful candidates (b)[ɑ:ru] and [ɑlɑɾɑi]. As with previous examples, the unfaithful candidates (b) are the output preferred by children’s grammar due to the higher ranking markedness constraints *STOPS and *GLIDES. Thus, to account for the gliding pattern, *STOPS and *GLIDES must outrank IDENT- MANNER.

For all examples of gliding, it is assumed that a violation of IDENT- FEATURE as (“do not change features”) is incurred because the major class feature [Manner – glides, and stops] are changed. Liquiding involves a change in [manner]; nevertheless, [manner] is the contrast between liquids and stops/glides.

## e. Stopping

Now consider the following stopping error patterns: /eli/>/eʈ̪i/ in **Liquid stopping**; /ɑʋɑɾɑi / > /ɑʈ̪ɑɾɑi/ in **Glide stopping**; and / fæn/ > /pæn/ in **Fricative Stopping**. The constraints relevant here are *LIQUIDS (“no liquids”), *GLIDES (“no glides”), and *FRICATIVES (“no fricatives”) and IDENT-CONTINUANT (“do not change [continuant]”).

For stopping, the markedness constraint against liquids, glides, and fricatives outrank the constraint that requires faithfulness to the [continuant] feature, as shown in (41). Of course, native and borrowed words of Tamil have the opposite ranking because liquids, glides (native words of Tamil), and fricatives (borrowed words of Tamil) occur in the productions of adult speakers.

**(41) Stopping**

***LIQUIDS:** Avoid liquids
***GLIDES:** Avoid glides

***FRICATIVES:** Avoid fricatives
**IDENT-CONTINUANT:** Preserve the continuant feature in the input segments
**Ranking:**
***LIQUIDS >> IDENT-CONTINUANT**
***GLIDES >> IDENT-CONTINUANT**
***FRICATIVES >> IDENT-CONTINUANT**

Stopping happens in segments, like *LIQUIDS, *GLIDES and *FRICATIVES changes into stops as in /eli/>/et̪i/, /ɑʋɑɾɑi / > / ɑt̪ɑɾɑi/ and /fæn/ > /pæn/. The tableaus (42, 43, and 44) give the description of the change in the manner of the segments in these words.

**(42)** Voiced alveolar lateral approximant /l/ changed as voiceless dental stop /t̪/ (**Liquid stopping)**

| /eli/ **'rat'** | ***LIQUIDS** | **IDENT – CONTINUANT** |
|---|---|---|
| a. [eli] | *! | |
| b. ☞ [et̪i] | | * |

***LIQUIDS >> IDENT-CONTINUANT**

**(43)** Voiced labiodental glide /ʋ/ changed as voiceless dental stop /t̪/ (**Glide stopping**)

| /ɑʋɑɾɑi / 'Indian bean' | ***GLIDES** | **IDENT – CONTINUANT** |
|---|---|---|
| a. [ɑʋɑɾɑi] | *! | |
| b. ☞ [ɑt̪ɑɾɑi] | | * |

***GLIDES >> IDENT-CONTINUANT**

**(44)** Voiceless labiodental fricative /f/ changed as voiceless bilabial stop /p/ (**Fricative Stopping**)

| / fæn/ 'fan' | ***FRICATIVES** | **IDENT - CONTINUANT** |
|---|---|---|
| a. [fæn] | *! | |
| b. ☞ [pæn] | | * |

***FRICATIVES >> IDENT-CONTINUANT**

This ranking is shown in tableaus (42, 43, and 44), with the highest-ranked constraint on the left. For the words /eli/, /ɑʋɑɾɑi/, and /fæn/, two possible output candidates are shown on the left side of the tableau: the faithful candidates (a) [eli], [ɑʋɑɾɑi], and [fæn], and the unfaithful candidates (b) [et̪i], [ɑt̪ɑɾɑi], and [pæn]. Because *LIQUIDS, *GLIDES, and *FRICATIVES outrank IDENT-CONTINUANT, it is a more serious violation of children's grammar to have liquids, glides, and fricatives in the output. Therefore, candidates (a) incur a fatal violation of *LIQUIDS, *GLIDES, and *FRICATIVES. Candidates (b), the less faithful candidates, violate IDENT-CONTINUANT because the output form includes a stop rather than a fricative. This is a nonfatal violation, making attested candidates (b) the winning output form. Thus, to account for children's stopping pattern, *LIQUIDS, *GLIDES, and *FRICATIVES are ranked above IDENT-CONTINUANT.

## f. Height Positioning

The problems are found in height positioning in children's speech across their initial developmental phase of phonology. In the examples /ɑɻɑkɑn/**>** /ɑɻɑken/ for **Vowel raising;** and /ilɑi/ > /ɑlɑi/ for **Vowel lowering,** low vowel /ɑ/ of /ɑɻɑkɑn/ and high vowel /i/ of /ilɑi/> have undergone positioning problems reflecting in high vowel /e/ as /ɑɻɑken/ and low vowel /ɑ/as /ɑlɑi/.

The analysis of this height positioning can be explained in terms of harmony of adjacent segments, where:

(a) /k/ velar stop segment and /n/ alveolar nasal segment, which precedes and follows the low vowel /ɑ/ in /ɑɻɑkɑn/ are coronals, may be made to move the low vowel into high-mid vowel segment /e/; and
(b) As /i/ is the open syllable without onset or coda and followed by /l/ alveolar lateral segment, which is followed by a diphthong /ɑi/ in /ilɑi/ are continuant and non-consonants, made to move the high vowel /i/ into low vowel segment /ɑ/ as surfaced as /ɑlɑi/

The constraints relevant here are *LOW ("no raising/change in height") and *HIGH ("no lowering/change in height"), under markedness constraint and IDENT-HEIGHT (“do not change [height]”) under faithfulness constraint.

For height positioning, the markedness constraint against *LOW, and *HIGH outranks the constraint that requires faithfulness to the [height] feature, as shown in (45). Of course, words in Tamil have the opposite ranking because height positioning occurs as such in the productions of adult speakers and does not get lowered or raised.

**(45) Height Positioning**

***LOW:** Avoid low vowels
***HIGH:** Avoid High vowels
**IDENT-HEIGHT:** Preserve the height feature in the input segments
**Ranking:**
***LOW >> IDENT-HEIGHT**
***HIGH >> IDENT-HEIGHT**

Height Positioning errors like lowering and raising happen in vowel segments, like *LOW, and *HIGH changes into high and low vowels as in /ɑɻɑkɑn/**>** /ɑɻɑk**e**n/ and /**i**lɑi/ > /ɑlɑi/. The tableaus (46 and 47) give the description of the change in the height of the segments in these words.

**(46)** Central unrounded low short vowel /ɑ/ changed as front unrounded high-mid vowel /e/ (**Vowel raising**)

| /ɑɻɑkɑn / ‘handsome’ | ***LOW** | **IDENT-HEIGHT** |
|---|---|---|
| a. [ɑɻɑkɑn] | *! | |
| b. ☞ [ɑɻɑken] | | * |

***LOW >> IDENT-HEIGHT**

**(47)** Front rounded high vowel /i/ changed as central unrounded low vowel /ɑ/ (**Vowel lowering**)

| / ilɑi/ ‘leaf’ | ***HIGH** | **IDENT-HEIGHT** |
|---|---|---|
| a. [ilɑi] | *! | |
| b. ☞[ɑlɑi] | | * |

***HIGH >> IDENT-HEIGHT**

The ranking shown in (45) is explained in tableaus (46) and (47). For the words /ɑɻɑkɑn / and /ilɑi/, the two possible output candidates are the faithful candidates (a) [ɑɻɑkɑn] and [ilɑi] and the unfaithful candidates (b) [ɑɻɑken] and [ɑlɑi]. Here *LOW and *HIGH outranks IDENT-HEIGHT, as it is a more serious violation of children's grammar to have low vowels instead of high vowels and high vowels instead of low vowels in the output. Therefore, candidates (a) incur a fatal violation of *LOW and *HIGH. Candidates (b), the less faithful candidates, violate IDENT-HEIGHT because the output form includes a high instead of a low vowel and a low instead of a high vowel. This violation is a nonfatal violation, making attested candidates (b) the winning output form. Thus, to account for children's assimilation pattern, *LOW and *HIGH are ranked above IDENT-HEIGHT.

## g. Duration Shift

Tamil vowel phonemes contrast in duration, which results in long vowels as phonemes in this language, as explained in chapter 2. Children in their initial developmental phase used to have a problem with duration sustaining. It can be seen in the examples (i) /oɭi/ > /o:ɭi/ in **Vowel lengthening;** (ii) /ɑ:ɳʈ̪ɑi/ > /ɑɳʈ̪ɑi/ in **Vowel shortening;** and (iii) /ɑippɑci/ > /ɑppɑci/ in **Monophthongization**; where short vowel /o/ of /oli/ and long vowel /ɑ:/ of /ɑ:ɳʈ̪ɑi/ and diphthong /ɑi/ (which has a heavy syllable weight of long vowel and diphthong) of /ɑippɑci/ have undergone a duration sustaining problems surfacing with long vowel /o:/ as /o:li/ and short vowel /ɑ/ as /ɑɳʈ̪ɑi / and monophthong /ɑ/ as /ɑppɑci/.

The constraints relevant here are *LAX ("lengthening/change in length") and *TENSE ("shortening, monophthongization/change in length"), under markedness constraint and IDENT-LENGTH ("do not change [length]") under faithfulness constraint.

For duration sustaining, the markedness constraint against *LAX and *TENSE outranks the constraint that requires faithfulness to the [LENGTH] feature, as shown in (48). Of course, words of Tamil have the opposite ranking because duration sustaining occurs as such in the productions of adult speakers and does not get lengthened, shortened, or monophthongized.

**(48) Duration shift**

> ***LAX:** Avoid short vowels
> ***TENSE:** Avoid long vowels/diphthongs
> **IDENT-LENGTH:** Preserve the duration feature in the input segments.
> **Ranking:**
> ***LAX >> IDENT-LENGTH**
> ***TENSE >> IDENT-LENGTH**

Duration shifting problems like shortening, lengthening, and monophthongization happens in vowel segments, like LAX (short vowel), and TENSE (long vowel/diphthong), changes into long, and short or monophthong vowels as in /**o**li/ > /**o**:li/; /ɑ:n̪t̪ɑi/ > /ɑn̪t̪ɑi/; and /ɑippɑci/ > /ɑppɑci/. The tableaus (49, 50, and 51) give the description of the change in length of the segments in these words.

**(49)** Back rounded short vowel /o/ changed as back rounded long vowel /o:/ (**Vowel lengthening**)

| /oɭi/ 'light' | *LAX | IDENT-LENGTH |
|---|---|---|
| a. [oɭi] | *! | |
| b. ☞ [o:ɭi] | | * |

***LAX >> IDENT-LENGTH**

**(50)** central unrounded long vowel /ɑ:/ changed as central rounded short vowel /ɑ/ (**Vowel shortening**)

| /ɑ:n̪t̪ɑi/ 'owl' | *TENSE | IDENT-LENGTH |
|---|---|---|
| a. [ɑ:n̪t̪ɑi] | *! | |
| b. ☞ [ɑn̪t̪ɑi] | | * |

***TENSE >> IDENT-LENGTH**

**(51)** Diphthong /ɑi/ changed as central unrounded short vowel /ɑ/ (**Monophthongization**)

| / ɑippɑci / 'Tamil month' | *TENSE | IDENT-LENGTH |
|---|---|---|
| a. [ɑippɑci] | *! | |
| b. ☞ [ɑppɑci] | | * |

***TENSE >> IDENT-LENGTH**

The ranking shown in (48) is explained in tableaus (49), (50), and (51). For the words /oli/, /ɑ:ɳʈ̪ɑi/, and /ɑippɑci/, two possible output candidates are: the faithful candidates (a) /oli/, /ɑ:ɳʈ̪ɑi/, and /ɑippɑci/ and the unfaithful candidates (b) /o:li/ /ɑɳʈ̪ɑi/ and /ɑppɑci/. Here *LAX, and *TENSE outranks IDENT-LENGTH, as they are the more serious violations of children's grammar to have short vowels, long vowels and diphthongs without duration sustaining in the output. Therefore, candidates (a) incurs a fatal violation of *LAX, and *TENSE. Candidates (b), the less faithful candidates, violate IDENT-LENGTH, because the output form includes a long instead of a short vowel, a short instead of a long vowel and a monophthong instead of a diphthong. This is a nonfatal violation, making attested candidates (b) the winning output form. Thus, to account for children's vowel duration pattern, *LAX, and *TENSE are ranked above IDENT-LENGTH.

## C. Assimilation Processes

The following assimilation processes have been applied by the typically developing children in varying degrees. More specifically, four different assimilation processes have been noticed in this analysis. These processes are subtypes of the processes of consonant harmony like (i) Nasalization as in mɑ:ʈu/ > /mɑ:nu/; (ii) labialization/Bilabial assimilation (Denasalization) as in /pɑɳɑm/ > /pɑpɑm/, (iii) Nasal assimilation as in /t̪ɑmpi/> /t̪ɑmmi/, and (iv) Velarization/ Velar assimilation as in /kɑt̪ɑʋu/ > /kɑkɑʋu/.

The constraints relevant here are **AGREE-NASAL** ("Agree with neighboring nasals"); **AGREE-LABIAL** ("Agree with neighboring labials"); and **AGREE-DORSAL** ("Agree with neighboring dorsals"); under markedness constraint and **IDENT-MANNER** and **IDENT -PLACE** ("don't change [manner/ place]") under faithfulness constraint.

For assimilation, the markedness constraint against AGREE-NASALS, AGREE-LABIALS, and AGREE-DORSALS outrank the constraint that requires faithfulness to the [manner/place] feature, as shown in (52). Of course, words of Tamil have the opposite ranking because coronals, nasals, labials, and dorsals occur as such in the productions of adult speakers and do not get assimilated.

**(52) Assimilation**

**AGREE-NASAL:** Change the segment due to neighbouring nasals
**AGREE-LABIAL:** Change the segment due to neighboring labials
**AGREE- DORSAL:** Change the segment due to neighboring dorsals
**IDENT-MANNER:** Preserve the manner feature in the input segments
**IDENT -PLACE:** Preserve the place feature in the input segments
**Ranking:**
**AGREE-NASALS >> IDENT-MANNER**
**AGREE-LABIALS >> IDENT-MANNER**
**AGREE- DORSALS >> IDENT-PLACE**

Assimilation happened in segments, like *CORONALS, *NASALS *LABIALS, and *DORSALS changes into nasal, bilabial, nasal, and velar as in mɑːʈu/ > /mɑːnu/; /pɑɳɑm/ > /pɑpɑm/, /t̪ɑmpi/> /t̪ɑmmi/, and /kɑt̪ɑʋu/ > /kɑkɑʋu/. The tableaus (53), (54), (55), and (56) illustrate the description of the change in the manner or place of the segments in these words.

**(53)** Voiceless retroflex stop /ʈ/ changed as voiced alveolar nasal /n/ (**Nasalization**)

| / mɑ:ʈu / ‘cow’ | AGREE-NASAL | IDENT-MANNER |
|---|---|---|
| a. [mɑ:ʈu] | *! | |
| b. ☞ [mɑ:nu] | | * |

**AGREE-NASAL >> IDENT-MANNER**

**(54)** Voiced alveolar nasal /ɳ/ changed as voiceless bilabial stop /p/ can be either **Denasalization** or **Bilabial assimilation**

| / paɳam / ‘money’ | AGREE-LABIAL | IDENT-MANNER |
|---|---|---|
| a. [paɳam] | *! | |
| b.☞ [papam] | | * |

**AGREE-LABIAL >> IDENT-MANNER**

**(55)** Voiceless bilabial stop /p/ changed as voiced bilabial nasal /m/ (**Nasal assimilation**)

| / t̪ampi/ ‘younger brother’ | AGREE-NASAL | IDENT-MANNER |
|---|---|---|
| a. [t̪ampi] | *! | |
| b. ☞ [t̪ammi] | | * |

**AGREE-NASAL >> IDENT-MANNER**

**(56)** Voiceless dental stop /t̪/ changed as voiceless velar stop /k/ (**Velar Assimilation**)

| /kat̪aʋu/ ‘door’ | AGREE-DORSAL | IDENT-PLACE |
|---|---|---|
| a. [kat̪aʋu] | *! | |
| b. ☞ [kakaʋu] | | * |

**AGREE- DORSAL >> IDENT-PLACE**

The ranking shown in (52) is explained in tableaus (53), (54), (55), and (56). For the words, mɑ:ʈu/, /paɳam/, /t̪ampi/, and /kat̪aʋu/, two possible output candidates are; the faithful candidates (a) mɑ:ʈu/, /paɳam/, /t̪ampi/, and /kat̪aʋu/, and the unfaithful candidates (b) /mɑ:nu/, /papam/, /kakaʋu/. Because AGREE-NASAL, AGREE-LABIAL, and AGREE-DORSAL outrank

IDENT-MANNER and IDENT-PLACE, it is a more serious violation of children's grammar to have coronals, nasals, labials, and dorsals without assimilated in the output. Therefore, candidates (a) incur a fatal violation of AGREE-NASAL, AGREE-LABIAL, and AGREE-DORSAL. Candidates (b), the less faithful candidates, violate IDENT-MANNER and IDENT-PLACE, because the output form includes assimilation of nearby segments. This is a nonfatal violation, making attested candidates (b) the winning output form. Thus, to account for children's assimilation patterns, AGREE-NASAL, AGREE-LABIAL, and AGREE-DORSAL are ranked above IDENT-MANNER/IDENT-PLACE.

## Metathesis

A satisfactory analysis of consonant harmony (CH) and long-distance metathesis should help us figure out why these processes emerge in phonological development, how they are related, and the reasons behind common patterns observed across children. The metathesis found in children's speech helps us understand the role of consonant harmony and long-distance metathesis. In the example /mɑt̪t̪.ɑɑ.ppu/, segments t̪t̪ and pp are juxtaposed with a long vowel 'ɑɑ' in-between, have got interchanged as /mɑpp.ɑɑ.t̪t̪u/. The analysis of this metathesis can be explained in terms of CH, where /m/, a bilabial segment in the initial position of the initial syllable harmony made to move the bilabial segments /pp/, which is an onset of the final syllable to coda position of initial syllable and segments /t̪t̪/ to the onset position of the final syllable.

**(57)** Transposition of two segments t̪t̪ (Coda) of the first syllable mɑt̪t̪ and pp (Onset) of the final syllable ppu is a metathesis.

| / mɑt̪t̪.ɑɑ.ppu / 'fire cracker' | ***SEQUENCE (coronal…labial)** | **LINEARITY** |
|---|---|---|
| a. [mɑt̪t̪.ɑɑ.ppu] | *! | |
| b. ☞ [mɑppɑɑ.t̪t̪u] | | * |

**(58) Consonant harmony and distant segment metathesis**

> ***SEQUENCE (coronal…labial):** Change in the sequence of segments coronal…labial.
> **LINEARITY:** Preserve the linearity in the sequence of segments
> **Ranking**
> ***SEQUENCE (coronal…labial) >> LINEARITY**

To review, the generalization regarding ranking in (58) states that if coronal consonants undergo harmony within a child's grammar, as in maʈ̪ʈ̪ as mapp; non-coronal consonants undergo harmony as well, as in /kɑmpu/ 'stick' > /pɑmpu/. Concerning triggers, if labials trigger assimilation as in /pɑɳ̪ʈ̪u/ 'ball' > /pɑmpu/, velars do as well as in /kɑɲci/ 'porridge' > /kɑkki/; in other words, the presence of labial harmony in a child's speech implies the presence of velar harmony. Also, this states that the presence of perseverative harmony in a child's grammar implies the presence of anticipatory harmony, meaning that harmony is bidirectional.

The ranking shown in (58) is explained in tableau (57). For the word /mɑʈ̪ʈ̪ɑɑ.ppu/, two possible output candidates are; the faithful candidate (a) [mɑʈ̪ʈ̪ɑɑ.ppu], and the unfaithful candidate (b) [mɑppɑɑ.ʈ̪ʈ̪u]. Because *SEQUENCE (coronal…labial) outranks LINEARITY, it is a more serious violation of children's grammar to have a sequence of coronals….. labials in the output. Therefore, candidate (a) incurs a fatal violation of *SEQUENCE (coronal…labial). Candidate (b), the less faithful candidate, violates LINEARITY, as the output form includes a metathesis of coronal and labial segments. This is a nonfatal violation, making attested candidate (b) the winning output form. Thus, to account for children's metathesis pattern, *SEQUENCE (coronal…labial) is ranked above LINEARITY.

### D. Cluster Simplification

Typically, onset clusters are acquired after singletons across developing language structures in children (Jakobson, 1968).

Children must pass through a stage in which target clusters are wrongly produced. However, children's wrong production of clusters can be in a number of different forms. This study traces three possible patterns observed in children's production: reduction, epenthesis, and coalescence. These error patterns are also seen in the studies of Chin, (1993); Chin & Dinnsen, (1992); Edwards & Shriberg, (1983); Greenlee, (1974); Ingram, (1989a); Smit, (1993).

Reduction is when a target cluster, i.e., multiple elements, surfaces as a single segment. In this, one of the elements of the cluster remains as a singleton, for example, "school," [sku:l] being produced as [ku:l], with the segment /s/ of /sk/ is being omitted and /k/ remains as singleton.

Epenthesis is the process where the insertion of a vowel between the target cluster happens, as in "treɪn" being realized as [tereɪn].

Coalescence is when a target cluster is realized as a singleton, but that substitute is not either one of the segments of the target cluster; instead, it is a segment that shares properties of the cluster regarding place and manner of articulation. Here, "treɪn" may be produced as [leɪn]: [l] shares the manner of stopping with /t/ and the alveolar fricative place with [l] of the /tr-/ cluster.

## a. Reduction

Children reduce clusters to singletons, indicating that their utterance has the constraint *COMPLEX against syllables beginning with clusters. So *COMPLEX must be highly ranked. Still, this constraint does not account for the exact way target clusters will be reduced. If the reduction of clusters to a single segment has to be exclusively accounted for, it is essential to put forward some other equally high-ranking constraints (Barlow, 1999, 2001).

These constraints have to prevent the alternative patterns of cluster reduction epenthesis (i.e., DEP – no insertion) and coalescence (i.e., UNIFORMITY – no change of segment), along with the lower ranking constraint, which prevents deletion (i.e., MAX). The possible ranking is shown in (59), along with a subsequent tableau that illustrates the reduction pattern in (60 and 61).

**(59) Cluster reduction**

***COMPLEX:** Avoid consonant clusters
**DEP:** Every output segment must have a corresponding segment in the input (No insertion.)
**UNIFORMITY:** Input segments must correspond to the output segments without merging two segments. (preventing coalescence)
**MAX:** Input segments must correspond to the output segments. (No deletion.)
**Ranking:**
***COMPLEX, DEP, UNIFORMITY >> MAX**

**(60)** Cluster reduction (Onset): /**s**ku:l/ > /ku:l/

| / **s**ku:l / 'School' | *** COMPLEX** | **DEP** | **UNIFORMITY** | **MAX** |
|---|---|---|---|---|
| a. [**s**ku:l] | *! | | | |
| b. ☞[ku:l] | | | | * |
| c. [suku:l] | | *! | | |
| d. [t̺u:l] | | | *! | |

**(61)** Cluster reduction (**Coda**): / vɑ:jkkɑ:l / > / vɑ:kkɑ:l /

| /vɑ:jkkɑ:l/ 'canal' | *** COMPLEX** | **DEP** | **UNIFORMITY** | **MAX** |
|---|---|---|---|---|
| a. [vɑ:jkkɑ:l] | *! | | | |
| b. ☞[vɑ:kkɑ:l] | | | | * |
| c. [vɑ:jikkɑ:l] | | *! | | |
| d. [vɑ:lkɑ:l] | | | *! | |

If we evaluate each candidate in the tableaus (60) and (61), it is evident that the faithful candidates (a) undergo a fatal violation of *COMPLEX, as it matches with target [sk-] and [jk] cluster. As vowel /u/ and /i/ insertion is between the target /sk/ and /jk/ cluster in the candidates (c), they incur a fatal violation of DEP. In the same way, candidates (d) incur a fatal violation of UNIFORMITY because of the coalescence; [t̪] in place of the /sk-/ cluster and [l] in place of /jk/.

However, candidate (b) experienced the lowest ranked violation, MAX, because their segments in the output do not correspond to the input. Candidates (b) do not violate any other of the higher-ranked constraints; thus, it is chosen as the most harmonic.

So for the cluster reduction pattern; the exact ranking of constraints expects that, for a child grammar that allows cluster reduction; deleting a segment is a less severe violation as in candidates (b) than allowing a cluster to surface as in candidates (a) or inserting a segment as in candidates (c), or coalescence to occur as in candidates (d).

### b. Epenthesis

According to Barlow (1999), for a pattern of epenthesis in the children's production, the same four constraints of cluster reduction (*COMPLEX, DEP, MAX, and UNIFORMITY) account for epenthesis too in a relative ranking. In contradiction to the ranking done for a reduction in which MAX has a low ranking, MAX has to be ranked high as epenthesis is for insertion and not for deletion, which deals with DEP, which has to be a lower-ranked constraint as insertion is a less serious violation in this case. The probable ranking of constraints for epenthesis is shown in (62) and explained in tableau (63).

**(62) Ranking: *COMPLEX, MAX, UNIFORMITY >> DEP**

**(63)** Epenthesis: /treɪn / > [təreɪn]

| /treɪn/ 'train' | ***COMPLEX** | **MAX** | **UNIFORMITY** | **DEP** |
|---|---|---|---|---|
| a. [treɪn] | *! | | | |
| b. [teɪn] | | *! | | |
| c. ☞[təreɪn] | | | | * |
| d. [leɪn] | | | *! | |

***COMPLEX, MAX, UNIFORMITY >> DEP**

As happened in cluster reduction, in tableau (63) also, candidate (a) incurs a fatal violation of *COMPLEX as the output sequence has [tr], and Candidate (d) incurs a fatal violation of UNIFORMITY as the coalescence of the [tr] as [l] in the output. Since all segments of the input are not present in the output, Candidate (b) also incurs a fatal violation of MAX. Whereas candidate (c) is considered optimal, as it fits in with the constraints; *COMPLEX as there is no onset cluster; MAX as all input segments match the output; and UNIFORMITY as there is no coalescence.

The insertion of schwa in candidate (c) violates the lowest-ranked constraint DEP. For epenthesis pattern, the less serious violation of the grammar is to insert a segment as in candidate (c) than a cluster to surface as in candidate (a), or a segment to go unparsed as in candidate (b), or two segments to coalesce as in candidate (d).

## c. Coalescence

The pattern, Coalescence found in children's speech also depends on the same four constraints. However, here UNIFORMITY is ranked lowest, and the other three constraints, *COMPLEX, MAX, and DEP are ranked higher as in (64).

**(64) Ranking: *COMPLEX, MAX, DEP >> UNIFORMITY**

**(65)** Coalescence: /sku:l/ > /t̪u:l/

| /sku:l/ 'school' | *COMPLEX | MAX | DEP | UNIFORMITY |
|---|---|---|---|---|
| a. [sku:l] | *! | | | |
| b. [ku:l] | | *! | | |
| c. [suku:l] | | | *! | |
| d. ☞ [t̪u:l] | | | | * |

***COMPLEX, MAX, DEP >> UNIFORMITY**

From tableau (65), it is inferred that candidate (a) experiences a fatal violation of *COMPLEX as the occurrence of clusters is found, and candidate (b) experiences fatal violations of MAX due to the segmental mismatch between input and output forms. Candidate (c), due to the schwa insertion, experiences a fatal violation of DEP. All these candidates are less optimal than Candidate (d) since they violate the most highly ranked constraints. Candidate (d) is selected as an optimal candidate as it violates only lower-ranked constraint UNIFORMITY.

According to the children's grammar, the presence of coalescence is a less serious violation. Coalesce segments have less serious violations as in candidate (d) rather than it is for a cluster to surface as in candidate (a), or for a segment that goes unparsed as in candidate (b), or for a segment inserted as in candidate (c) (Barlow, 1997; Gnanadesikan, 1996).

## E. Multi-variation (Multiple processes in a single word)

Until this topic, children's error patterns had been analysed using various constraints. However, all those words had a single error or change that has been evaluated individually, where two (one markedness and one faithfulness) constraints are ranked on one another. Also, these types of errors are simple to explain. However, children's error patterns also show multiple errors in a single word uttered. Apart from the phonological processing with single phonemes, data from typically developing children revealed phonological processes with multi-phoneme in a single word. For example:

- /uɾɑl/ > /iʋɑ/ where vowel fronting, liquid gliding, and final consonant deletion have occurred;
- /t̪ɑnni/> /t̪it̪t̪i/ where vowel harmony and dental assimilation (Denasalization) have occurred;
- /ɑiʋɑɾ/ > /ɑlɑ/ where monophthongization, glide liquiding, and final consonant deletion have occurred;
- /cɑmɑijɑl/> /t̪ɑmɑjɑ/ where palatal fronting, monophthongization, and final consonant deletion have occurred;
- /ɑɲcɑl/> /ɑccu/ where palatal assimilation, final consonant deletion, and vowel raising have occurred;

- /mɑt̪t̪ɑ:ppu/> /ɑppɑt̪t̪u/ where initial consonant deletion, metathesis and, vowel shortening have occurred;
- /ɑŋkɑm/> /ɑt̪t̪e:/ where velar assimilation, velar fronting, final consonant deletion, vowel raising, and vowel lengthening have occurred;

Sample data analysis of these error patterns using OT are described as follows.

**1. /uɾɑl/ > /iʋɑ/** Target word: /uɾɑl/ Child's Utter ance: /iʋɑ/

Descriptions of segmental changes (phonological processes) in surface form from underlying form (utterance of the child) /iʋɑ/ are;

a. **Liquid gliding:** Voiced alveolar flap /ɾ/ changed as voiced labiodental approximant/ʋ/ as /uɾɑl/ > /uʋɑl/ - *LIQUID, IDENT-CONSONANTAL
b. **Final Consonant Deletion:** Deletion of voiced alveolar lateral approximant /l/ as uʋɑl > uʋɑ - *CODA, MAX
c. **Vowel fronting:** High back rounded short vowel /u/ changed as high front unrounded short vowel /i/ as uʋɑ > iʋɑ - *POSTERIOR, IDENT-PLACE

**(66)** Constraints ranking tableau for the word /uɾɑl/ "grinder."

| /uɾɑl/ 'grinder' | *LIQUID | *CODA | *POSTERIOR | IDENT-CONSONANTAL | MAX | IDENT-PLACE |
|---|---|---|---|---|---|---|
| a. [uɾɑl] | *! | * | * | | | |
| b. ☞[iʋɑ] | | | | * | * | * |

**(67) Ranking: *LIQUID, *CODA, *POSTERIOR >> IDENT-CONSONANTAL, MAX, IDENT-PLACE**

From tableau (66), it is inferred that the candidate (a) experiences a fatal violation of ***Liquid, *Coda, *Posterior** as the occurrence of liquid /ɾ/, final consonant /l/, and posterior vowel /u/ is found in [uɾɑl]; and candidate (b) experience optimal violation of **Ident-Consonantal, Max, Ident-Place** due to the segmental mismatch between input /u/, /ɾ/, and /l/ of [uɾɑl] and corresponding output /i/, /ʋ/ and /ɸ/ of [iʋɑ] form. Thus, to account for this multi-phoneme deviant pattern, ***Liquid, *Coda, *Posterior** is ranked above **Ident-Consonantal, Max, Ident-Place**.

**2. /t̪ɑnni/> /t̪it̪t̪i/** Target word: /t̪ɑnni/ Child's Utterance: /t̪it̪t̪i/

Descriptions of segmental changes (phonological processes) in surface form from underlying form (utterance of the child) /t̪it̪t̪i/ are;

a. **Dental Assimilation/ Denasalization:** Dental /t̪/ assimilates and changes retroflex /ɳɳ/ into /t̪t̪/ as t̪ɑɳɳi > t̪ɑt̪t̪i – *Agree- Coronal, Ident- Manner
b. **Vowel Raising**: Low unrounded short vowel /ɑ/ changed as high front unrounded short vowel /i/, as t̪ɑt̪t̪i > t̪it̪t̪i - *Agree- High, Ident- Height

**(68)** Constraints ranking tableau for the word /t̪ɑɳɳi/ 'water'

| /t̪ɑɳɳi/ 'water' | **Agree-Coronal** | **Agree-High** | **Ident-Manner** | **Ident-Height** |
|---|---|---|---|---|
| a. [t̪ɑɳɳi] | *! | * | | |
| d. ☞[t̪it̪t̪i] | | | * | * |

**(69) Ranking: *Agree- Coronal, *Agree- High >> Ident-Manner, Ident- Height**

From tableau (68), it is inferred that the candidate (a) experiences a fatal violation of ***Agree- Coronal, *Agree- High** as the occurrence of low vowel /ɑ/, and retroflex nasal /ɳɳ/ is found in [t̪ɑɳɳi] and candidate (b) experience optimal violation of **Ident-Manner, Ident-Height**, due to the segmental mismatch between input /ɑ/ and /ɳɳ/ of [t̪ɑɳɳi] and corresponding output /i/,

/t̪t̪/ of [t̪it̪t̪i] form. Thus, to account for this multi-phoneme deviant pattern, *AGREE- CORONAL, *AGREE- HIGH is ranked above IDENT- MANNER, IDENT- HEIGHT.

**3.** /ɑiʋɑɾ/ > **/ɑlɑ/** Target word: / ɑiʋɑɾ / Child’s Utterance: /ɑlɑ/

Descriptions of segmental changes (phonological processes) in surface form from underlying form (utterance of the child) /ɑlɑ/ are;

- **a.** **Final Consonant Deletion:** deletion of voiced alveolar flap /ɾ/ as ɑilɑɾ > ɑilɑ - *CODA, MAX
- **b.** **Glide liquiding:** voiced labio-dental approximant /ʋ/ changed as voiced alveolar lateral approximant /l/ as ɑiʋɑɾ > ɑilɑɾ - *GLIDES, IDENT-MANNER
- **c.** **Monophthongization:** diphthong /ɑi/ substituted with Low central unrounded short vowel /ɑ/ as ɑiʋɑɾ > ɑiʋɑ - *TENSE, IDENT-LENGTH

**(70)** Constraints ranking tableau for the word /ɑiʋɑɾ/ ‘five members’

| /ɑiʋɑɾ/ ‘five members’ | *CODA | *GLIDES | *TENSE | MAX | IDENT-MANNER | IDENT-LENGTH |
|---|---|---|---|---|---|---|
| a. [ɑiʋɑɾ] | *! | * | * | | | |
| h. ☞ [ɑlɑ] | | | | * | * | * |

**(71) Ranking: *CODA, *GLIDES, *TENSE >> MAX, IDENT-MANNER, IDENT-LENGTH**

From tableau (70), it is inferred that the candidate (a) experiences a fatal violation of *CODA, *GLIDES, *TENSE as the occurrence of diphthong /ɑi/, labiodental glide /ʋ/, and liquid /ɾ/ is found in [ɑiʋɑɾ] and candidate (b) experience optimal violation of MAX, IDENT-MANNER, IDENT-LENGTH due to the segmental mismatch between input /ɑi/, /ʋ/, and /ɾ/ of [ɑiʋɑɾ] and corresponding output /ɑ/, /i/ and /ɸ/ of [ɑlɑ] form. Thus, to account for this multi-phoneme deviant pattern, *CODA, *GLIDES, *TENSE is ranked above MAX, IDENT-MANNER, and IDENT-LENGTH.

**4.** **/cɑmɑijɑl/> /t̪ɑmɑjɑ/** Target word: /cɑmɑijɑl/ Child's Utterance: /t̪ɑmɑjɑ/

Descriptions of segmental changes (phonological processes) in surface form from underlying form (utterance of the child) / t̪ɑmɑjɑ/ are;

- **a.** **Monophthongization -**diphthong /ɑi/ changed as Low unrounded short vowel /ɑ/ as cɑmɑijɑl > cɑmɑjɑl
- **b.** **Palatal fronting -** voiceless palatal stop /c/ changed as voiceless dental stop /t̪/ as cɑmɑjɑl > t̪ɑmɑjɑl
- **c.** **Final Consonant Deletion -** deletion of voiced alveolar lateral approximant /l/ as t̪ɑmɑjɑl > t̪ɑmɑjɑ

**(72)** Constraints ranking tableau for the word /cɑmɑijɑl/ 'cooking'

| /cɑmɑijɑl/ 'cooking' | ***TENSE** | ***DORSAL** | ***CODA** | **IDENT-LENGTH** | **IDENT-PLACE** | **MAX** |
|---|---|---|---|---|---|---|
| a. [cɑmɑijɑl] | *! | * | * | | | |
| h. ☞ [t̪ɑmɑjɑ] | | | | * | * | * |

**(73) Ranking: *TENSE, *DORSAL, *CODA >> IDENT- LENGTH, IDENT-PLACE, MAX**

From tableau (72), it is inferred that the candidate (a) experiences a fatal violation of ***TENSE, *DORSAL, *CODA** as the occurrence of dorsal palatal stop /c/, diphthong /ɑi/, and alveolar lateral /l/ is found in [cɑmɑijɑl] and candidate (b) experience optimal violation of **IDENT- LENGTH**, **IDENT-PLACE, MAX**, due to the segmental mismatch between input //, /ɑi/ and /l/ of [cɑmɑijɑl] and corresponding output /t̪/, /ɑ/ and /ɸ/ of [t̪ɑmɑjɑ] form. Thus, to account for this multi phoneme deviant pattern, ***TENSE, *DORSAL, *CODA** is ranked above **IDENT- LENGTH**, **IDENT-PLACE, MAX**.

**5.** /ɑɲcɑl/> /ɑccu/ Target word: /ɑɲcɑl/ Child's Utterance: /ɑccu/

Descriptions of segmental changes (phonological processes) in surface form from underlying form (utterance of the child) /ɑccu/ are;

a. **Palatal assimilation** - Voiced palatal nasal /ɲ/ changed as voiceless palatal stop /c/ as ɑɲcɑl > ɑccɑl - AGREE – STOP, IDENT-MANNER

**b. Final Consonant Deletion** - Deletion of voiced alveolar lateral approximant /l/ as ɑccɑl > ɑccɑ - *CODA, MAX

**c. Vowel raising** - Low central unrounded short vowel /ɑ/ changed as High back rounded short vowel /u/ as ɑccɑ > ɑccu - *LOW , IDENT-HEIGHT

**(74)** Constraints ranking tableau for the word /ɑɲcɑl/ 'post'

| /ɑɲcɑl/ 'post' | **AGREE – STOP** | ***CODA** | ***LOW** | **IDENT-MANNER** | **MAX** | **IDENT-HEIGHT** |
|---|---|---|---|---|---|---|
| a. [ɑɲcɑl] | *! | * | * | | | |
| h. ☞ [ɑccu] | | | | * | * | * |

**(75) Ranking: AGREE – STOP, *CODA, *LOW >> IDENT-MANNER, MAX, IDENT-HEIGHT**

From tableau (74), it is inferred that the candidate (a) experiences a fatal violation of **AGREE – STOP, *CODA, *LOW** as the occurrence of clusters /ɲc/, low vowel /ɑ/, and alveolar lateral /l/ is found in [ɑɲcɑl] and candidate (b) experience optimal violation of **IDENT-MANNER, MAX, IDENT-HEIGHT**, due to the segmental mismatch between input /ɲc/, /ɑ/ and /l/ of [ɑɲcɑl] and corresponding output /cc/, /u/ and /ϕ/ of [ɑccu] form. Thus, to account for this multi phoneme deviant pattern, **AGREE – STOP, *CODA, *LOW** is ranked above **IDENT-MANNER, MAX, IDENT-HEIGHT**.

**6. /mɑt̪t̪ɑ:ppu/>** **/ɑppɑt̪t̪u/** Target word: /mɑt̪t̪ɑ:ppu/ Child's Utterance: /ɑppɑt̪t̪u/

Descriptions of segmental changes (phonological processes) in surface form from underlying form (utterance of the child) /ɑppɑt̪t̪u/ are;

**a. Metathesis** - geminated voiceless dental stop /t̪/ interchanged with geminated voiceless bilabial stop /p/ as mɑt̪t̪ɑ:ppu > mɑppɑ:t̪t̪u - *SEQUENCE (coronal…labial), LINEARITY

b. **Initial Consonant Deletion -** deletion of initial voiced bilabial nasal /m/ as mɑppɑ:t̪t̪u > ɑppɑ:t̪t̪u - *ONSET, MAX

c. **Vowel shortening -** low unrounded long vowel /ɑ:/ changed as Low central unrounded short vowel /ɑ/ as ɑppɑ:t̪t̪u > ɑppɑt̪t̪u - *TENSE, IDENT-LENGTH

**(76)** Constraints ranking tableau for the word /mɑt̪t̪ɑ:ppu/ 'fire-cracker'

| /mɑt̪t̪ɑ:ppu/ 'fire-cracker' | ***SEQUENCE (coronal…labial)** | ***ONSET** | ***TENSE** | **LINEARITY** | **MAX** | **IDENT-LENGTH** |
|---|---|---|---|---|---|---|
| a. [mɑt̪t̪ɑ:ppu] | *! | * | * | | | |
| h. ☞ [ɑppɑt̪t̪u] | | | | * | * | * |

**(77) Ranking: *SEQUENCE (coronal…labial),*ONSET, *TENSE >> LINEARITY, MAX, IDENT-LENGTH**

From tableau (76), it is inferred that the candidate (a) experiences a fatal violation of ***SEQUENCE (coronal…labial), *ONSET, *TENSE** as the occurrence of initial voiced bilabial nasal /m/, /t̪t̪… pp/, and low long vowel /ɑ:/ is found in [mɑt̪t̪ɑ:ppu] and candidate (b) experience optimal violation of **LINEARITY, MAX, IDENT-LENGTH**, due to the segmental mismatch between input /m/, /t̪t̪… pp/, and /ɑ:/ of [mɑt̪t̪ɑ:ppu] and corresponding output /ɸ/, /pp…t̪t̪/ and /ɑ/ of [ɑppɑt̪t̪u] form. Thus, to account for this multi phoneme deviant pattern, ***SEQUENCE (coronal…labial),*ONSET, *TENSE** is ranked above **LINEARITY, MAX, IDENT-LENGTH**.

**7.** /ɑŋkɑm/> /ɑt̪t̪e:/ Target word: /ɑŋkɑm/ Child's Utterance: /ɑt̪t̪e:/

Descriptions of segmental changes (phonological processes) in surface form from underlying form (utterance of the child) /ɑt̪t̪e:/ are;

a. Velar assimilation - voiced velar nasal /ŋ/changed as voiceless velar stop /k/ as ɑŋkɑm > ɑkkɑm - AGREE-STOP, IDENT-MANNER

b. Velar fronting - voiceless velar stop clusters /kk/ changed as voiceless dental stop /t̪t̪/ as ɑkkɑm > ɑt̪t̪ɑm - *DORSAL, IDENT-PLACE

c. Final Consonant Deletion - Deletion of final voiced bilabial nasal /m/ in a word as ɑt̪t̪ɑm > ɑt̪t̪ɑ - *CODA, MAX

d. Vowel rising - Low central unrounded short vowel /ɑ/ changed as High front unrounded short vowel /e/ as ɑt̪t̪ɑ > ɑt̪t̪e - *LOW, IDENT-HEIGHT

e. Vowel lengthening - High front unrounded short vowel /e/ changes as High front unrounded long vowel /e:/ as ɑt̪t̪e > ɑt̪t̪e**:** - *LAX, IDENT-LENGTH

**(78)** Constraints ranking tableau for the word /ɑŋkɑm/ 'part'

| /ɑŋ.kɑm/ 'part' | **AGREE-STOP** | ***DORSAL** | ***CODA** | ***LOW** | ***LAX (II Syll)** | **IDENT-MANNER** | **IDENTPLACE** | **MAX** | **IDENT-HEIGHT (II Syll)** | **IDENTLENGTH (II Syll)** |
|---|---|---|---|---|---|---|---|---|---|---|
| a. [**ɑŋkɑm**] | *! | * | * | * | * | | | | | |
| x. ☞ [**ɑt̪t̪e**:] | | | | | | * | * | * | * | * |

**(79) Ranking: AGREE-STOP,*DORSAL, *CODA, *LOW, *LAX >> IDENT-MANNER, IDENT-PLACE, MAX, IDENT-HEIGHT, IDENT-LENGTH**

From tableau (78), it is inferred that the candidate (a) experiences a fatal violation of ***AGREE-STOP,*DORSAL, *CODA, *LOW, *LAX** as the occurrence of velar nasal /ŋ/, velar stop /k/, low short vowel /ɑ/, and bilabial nasal /m/ is found in [**ɑŋkɑm**] and candidate (b) experience optimal violation of **IDENT-MANNER, IDENT-PLACE, MAX, IDENT-HEIGHT, IDENT-LENGTH**, due to the segmental mismatch between input /ŋk/, /ɑ/ and /m/ of [**ɑŋkɑm**] and corresponding output /t̪t̪/, /e:/and /ɸ/ of [**ɑt̪t̪e**:]

form. Thus, to account for this multi phoneme deviant pattern, **AGREE-STOP,*DORSAL**, ***CODA**, ***LOW**, ***LAX** is ranked above **IDENT-MANNER, IDENT-PLACE, MAX, IDENT-HEIGHT, IDENT-LENGTH**.

### 3.3.2.2. *Constraints in Tamil Phonological Acquisition*

So after the thorough analysis of the error patterns like; deletion, backing, stopping, fronting, gliding, liquiding, height positioning, duration shift, assimilation, metathesis, and cluster simplification of the typically developing group under the OT, the systematic description of both the constraints are listed below.

i. For deletion *CODA, *ONSET, *NUCLEUS outranks MAX,
ii. In the process of backing and fronting, *LABIAL, *CORONAL-RETROFLEX, *CORONAL-DENTAL; *CORONAL-ALVEOLAR, *DORSAL-PALATAL, *DORSAL-VELAR; *POSTERIOR, *ANTERIOR, outranks IDENT-PLACE.
iii. For stopping,*LIQUIDS, *GLIDES, *FRICATIVES, outranks IDENT-CONTINUANT
iv. Ingliding,*LIQUIDS,*STOPS outranks IDENT-CONSONANTAL,
v. In liquiding, *STOPS, *GLIDES outranks IDENT-MANNER
vi. For the assimilation, AGREE-LABIALS, AGREE-NASALS, AGREE-DORSALS, AGREE-STOPS, AGREE-CORONALS, AGREE-HIGH outranks IDENT-PLACE, IDENT-MANNER, IDENT-HEIGHT
vii. In the process of metathesis, *SEQUENCE (coronal…labial) outranks LINEARITY
viii. In height positioning, *LOW, *HIGH outranks IDENT-HEIGHT
ix. For duration shift, *LAX, *TENSE outranks IDENT-LENGTH
x. For the process of cluster simplification *COMPLEX outranks DEP, UNIFORMITY, MAX,

Overall, the error patterns have accounted for 27 Markedness constraints and 11 Faithfulness constraints.

Markedness constraints are *CODA, *ONSET, *NUCLEUS, *LABIAL, *CORONAL-RETROFLEX, *CORONAL-DENTAL; *CORONAL-ALVEOLAR, *DORSAL-PALATAL, *DORSAL-

VELAR; *POSTERIOR, *ANTERIOR, *LIQUIDS, *STOPS, *GLIDES, *FRICATIVES, AGREE-LABIALS, AGREE-NASALS, AGREE-DORSALS, AGREE-STOPS, AGREE-CORONALS, AGREE-HIGH, *SEQUENCE (coronal…labial), *LOW, *HIGH, *LAX, *TENSE, and *COMPLEX,

Faithful constraints are MAX, IDENT-PLACE, IDENT-MANNER, IDENT-CONSONANTAL, IDENT-CONTINUANT, DEP, UNIFORMITY, LINEARITY, IDENT-LENGTH, and IDENT-HEIGHT.

The presence of the marked constraints shows the problems in the children. As the marked constraints decrease due to the advancement of their age, their speech intelligibility increases. The following tables show the percentage of the presence of marked constraints (MCs) in the children in all five age groups.

Table 16: Depicts the percentage of MCs in the segment deletion among five age groups.

| **Deletion** | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *CODA | 75% | 54% | 32% | 18% | 2% |
| *ONSET | 67% | 41% | 24% | 8% | - |
| *NUCLEUS | 35% | 2% | - | - | - |

**Table 17:** Depicts the percentage of MCs in the syllable deletion among five age groups.

| **Deletion** | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *ONSET , *NUCLEUS | 71% | 48% | 22% | 6% | - |
| *NUCLEUS, *CODA | 60% | 38% | 19% | 4% | - |
| *ONSET , *NUCLEUS, *CODA | 31% | 9% | 2% | - | - |

**Table 18:** Depicts the percentage of MCs seen in the Backing among five age groups.

| **Backing** | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *LABIAL | 81% | 69% | 48% | 26% | 12% |
| *CORONAL-RETROFLEX | 78% | 64% | 48% | 24% | 10% |
| *CORONAL-DENTAL | 56% | 41% | 24% | 8% | - |
| *DORSAL-PALATAL | 59% | 46% | 25% | 10% | 2% |
| *ANTERIOR | 29% | 14% | 3% | - | - |

**Table 19:** Depicts the percentage of MCs seen in the fronting among five age groups.

| **Fronting** | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *DORSAL-PALATAL | 93% | 72% | 68% | 32% | 19% |
| *DORSAL-VELAR | 80% | 69% | 51% | 30% | 12% |
| *CORONAL-RETROFEX | 91% | 70% | 68% | 33% | 20% |
| *CORONAL-ALVEOLAR | 67% | 38% | 21% | 6% | - |
| *POSTERIOR | 26% | 11% | 4% | - | - |

**Table 20:** Depicts the percentage of MCs seen in the stopping among five age groups.

| **Stopping** | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *LIQUIDS | 56% | 47% | 32% | 9% | 1% |
| *GLIDES | 71% | 54% | 41% | 20% | 10% |
| *FRICATIVES | 68% | 53% | 40% | 18% | 4% |

**Table 21:** Depicts the percentage of MCs seen in the gliding among five age groups.

| **Gliding** | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *LIQUIDS | 59% | 50% | 35% | 12% | 3% |
| *STOPS | 54% | 41% | 28% | 10% | 1% |

**Table 22:** Depicts the percentage of MCs seen in the liquiding among five age groups.

| **Liquiding** | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *STOPS | 56% | 45% | 30% | 12% | 3% |
| *GLIDES | 68% | 51% | 40% | 18% | 8% |

**Table 23:** Depicts the percentage of MCs seen in the assimilation among five age groups.

| **Assimilation** | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| AGREE-LABIALS | 78% | 54% | 24% | 12% | 1% |
| AGREE-NASALS | 80% | 63% | 42% | 23% | 6% |
| AGREE-DORSALS | 78% | 58% | 36% | 18% | 7% |
| AGREE-STOPS | 56% | 41% | 24% | 8% | - |
| AGREE-CORONALS | 51% | 38% | 21% | 8% | - |
| AGREE-HIGH | 21% | 10% | 1% | - | - |

**Table 24:** Depicts the percentage of MCs seen in the metathesis among five age groups.

| **Metathesis** | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *SEQUENCE | 38% | 21% | 11% | 1% | - |

**Table 25:** Depicts the percentage of MCs seen in the Height positioning among five age groups.

| Height positioning | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *LOW | 36% | 17% | 8% | - | - |
| *HIGH | 39% | 24% | 12% | 2% | - |

**Table 26:** Depicts the percentage of MCs seen in the duration shift among five age groups.

| Duration shift | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *LAX | 42% | 28% | 17% | 8% | - |
| *TENSE | 48% | 34% | 21% | 5% | - |

**Table 27:** Depicts the percentage of MCs seen in the Cluster simplification among five age groups.

| Cluster simplification | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| *COMPLEX – MAX | 87% | 68% | 54% | 32% | 19% |
| DEP | 34% | 12% | 3% | - | - |
| UNIFORMITY | 48% | 21% | 8% | - | - |

**Table 28:** Depicts the percentage of multiple variations seen among five age groups.

| | **1-2 years N= 20** | **2-3 years N=20** | **3-4 years N=20** | **4-5 years N=20** | **5-6 years N=20** |
|---|---|---|---|---|---|
| Multiple Variation Errors | 89% | 64% | 28% | 14% | 3% |

**Post-Script:**

It is inferred from the above tables that as age increases, the presence of marked constraints decreases. A similar result of declining use of phonological processes with increasing age has been reported across languages, including English (Grunwell, 1982; Hodson and Paden, 1983; Prather et al., 1975; Roberts et al., 1990), Malayalam (Sameer, 1998; Anita, 2015), Kannada (Sunil, 1998; Jayashree, 1990) Tamil (Kala and Lalitha Raja, 2016). In this investigation, a phonological process was said to persist even if present in a single child. Additionally, a phonological process was defined as persisting if it occurred even once in the child's speech. Lowe (1994) suggested that a single occurrence of a process qualifies its presence.

The study provided preliminary evidence for the development of phonology and the marked constraints and faithful constraints found in typically developing Tamil-speaking children. In this study, 27 marked constraints and 11 faithfulness constraints were identified; among these, constraints in substitution were the highest occurrence than other errors.

CHAPTER – 4

# Assessing Phonological Disorders (PD) using OT

## 4.1. Phonological Disorder

The attainment of intelligible speech is a prominent developmental achievement of preschool. Deficits in speech development are often due to significant clinical deficiencies like hearing, intelligence, or oral motor function. However, speech deficit is often seen in children with normal hearing and intelligence and out of sensorimotor or neurological disabilities. Such developmental disorders in phonology observed among children in the age group of two to eight years of age, which is a speech acquisition period, are often labeled as speech delay (Shriberg, 1980). When the child's conversational speech is more unintelligible compared to her/his age group, it is diagnosed as a speech delay/ disorder. According to a recent epidemiological study by M. Sidhu, P. Malhi and J. Jerath (2010), the prevalence of language delay is approximately 6 per cent in one to three-year-old children.

Its prevalence in younger children has not been reported previously, but those investigators suggested that approximately 14 per cent of three-year-old children would meet the criteria for speech delay. These phonological disorders exhibit some characteristics.

Table 29: Prevalence of language delay by age and sex of the child in India (Sidhu et al. 2013).

| Age | Boys % delayed (N) | Girls % delayed (N) | Total sample % delayed (N) |
|---|---|---|---|
| 12-23 months | 6.0 (50) | 6.5 (31) | 6.2 (81) |
| 24-35 months | 4.3 (23) | 7.7 (26) | 6.1 (49) |
| 12-35 months | 5.5 (73 | 7.0 (57) | 6.2 (130) |

### *4.1.1. Characteristics of Disordered Phonology*

Phonological process analysis of disordered child speech has firmly established that the children's pronunciation patterns are systematically related to the target adult pronunciation pattern. Studies have reported that the processes in children with disordered speech were similar to those in normal children. However, certain differences were found, largely related to the use of processes by children with disordered speech. Edward and Shriberg, 1983; Stoel-Gammon and Dunn 1985; Ingram 1976; Grunwell 1981b, 1985, 1987, 1988; (Cited in Ball and Kent 1997) classified them as:

1. Persisting normal processes
2. Chronological mismatch
3. Unusual processes
4. Variable use of processes
5. Systematic sound preference

1. **Persisting normal processes** are normal phonological processes that remain in a child's pronunciation patterns long after the age at which they would be likely to have been "suppressed," such as fronting of velars present in the speech of a child of 3;6 years to 3;9 years. Suppose the processes evidenced in a data sample are all normal and homogeneous regarding their chronology. In that case, a child's phonological development is delayed to a greater or lesser extent, depending on his or her age, or stopped at a particular stage of development.

2. **Chronological Mismatch** is the co-occurrence of some of the earliest normal simplifying processes with some patterns of pronunciation characteristics of later stages in phonological development, such as fronting of velars and the development of word-initial clusters present in the speech of a child aged 3; 6 to 3; 9 years. Such uneven progress is suggestive of disrupted or literally “disordered” development.
3. **Unusual processes** are simplifying patterns that have rarely been attested in normal speech development or that appear to be different from normal developmental processes and may, therefore, be idiosyncratic, as indicated above. This definition is cautiously constructed to not exclude the possibility that a child, who subsequently exhibits normal developmental achievements, might display apparently unusual patterns for a short period.
4. **Variable use of processes** occurs when multiple simplifying processes routinely operate with the same target type of structure so that the child’s realizations are variable and unpredictable: for example, Pie- [baɪ], Pour- [pɔ]. This variability is potentially progressive in that it entails the possible development of target contrast, and variability is abnormal when it is not potentially progressive.

   rake - [leɪk] rabbit - [abɪt]

   ring - [wɪŋ] red - [oɛd]
5. **Systematic sound preference**. It occurs when one type of consonant is used for an extensive range of target types. Often several different processes can be identified as resulting in a massive reduction of the phonological contrasts in a child’s system. The processes “conspire” to “collapse” the adult system of contrasts to one phone that the child prefers to use in his or her pronunciation patterns (i.e., what might be called a “favorite articulation”).
   - Fronting and voicing of /k/;
   - Fronting of /g/;
   - Stopping and voicing of / θ/,/s/,/ʃ/, /tʃ/;
   - Stopping of / z /, / ʒ /, / ʤ /;
   - Voicing of / t /;

Cluster reduction involving these targets; the co-occurrence of all these processes thus results in a systematic sound preference for [d]. The resultant massive lack of contrasts is clearly indicative of a severe phonological learning disability in a child who has developed in other aspects of language, such as the lexicon and grammar, beyond the earliest stages of language development. These processes normally co-occur up to about 2;6 years. These characteristics are most frequently applied in clinical diagnosis when no co-occurring anatomical or physiological conditions exist. However, as Ingram (1976) and Grunwell (1990) have demonstrated, phonological process analysis is amenable to other applications. Also, as children are developing pronunciation patterns in the context of an identifiable disability, there is likely to be an interaction between the normal pattern of development and the effects of the anatomical and/or physiological condition. For example, there is an identified tendency of backing in "cleft lip and palate speech"; which is the opposite of "normal fronting velars". Alongside this tendency, children with a repaired cleft will likely continue to evidence patterns of normal immaturities, such as stopping fricatives and affricates and gliding of liquids (Russell and Grunwell 1993).

## 4.2. Influence of Various Disorders in Assessment of Phonological Disorders

***Causes of Phonological Delay/Disorder***

**Phonological delay/disorder** may be due to various disorders. They are due to the disorders like Mental Retardation or Cognitive Delay, Hearing Loss, Specific Language Impairment, Bilingualism, Autism, Receptive aphasia, Cerebral palsy, and Cleft Lip/Palate.

***Mental retardation(MR)/Cognitive Delay(CD)***

Mental retardation is the major known cause of phonological disorder. These children exhibit global language delays. They also have a delay in auditory comprehension, use, and comprehension of gestures. On the whole, if there is severe mental retardation, which reflects in the slower acquisition of communicative speech. Their IQ level is below average, i.e., below 70 to 75. They are classified further as mild, moderate, severe, and profound. Mild mental retardation is an IQ between 50 to 70; moderate mental retardation is an IQ between 35 to 40 and 50 to 55; Severe mental retardation is an IQ between 20 to 25 and 35 to 40; and profound mental retardation is an IQ of less than 20 to 25.

### *Hearing loss (HL)*

Undamaged hearing in the initial years of life is essential to language and speech development. Hearing loss in the early development stage may lead to profound speech delay.

### *Maturation delay (developmental language delay)/Specific language Impairment (SLI)/ Delayed Speech and Language (DSL)*

Maturation delay (developmental language delay)/ Specific language impairment (SLI) or Delayed Speech and Language (DSL) or also called developmental dysphasia, reports for a significant percentage of delayed talkers who have no hearing loss or other language disorder that hold-up the mastery of language skills in children developmental delays. Here the development of the central neurologic process essential to produce speech is delayed. This problem is seen more among boys, who are often labelled as late bloomers. The diagnosis for these children is extremely good, and they usually have normal speech development by the age of school entry. It is one of the frequent childhood learning disabilities, affecting approximately 7 to 8 per cent of children in kindergarten. The impact of SLI persists into adulthood.

### *Bilingualism*

A home environment with two languages may cause a momentary delay in the commencement of both languages. However, in the initial phase of language development, these children are exposed to both languages. The comprehension of a bilingual child in both languages is normal for a child of the same age; however, the child usually becomes skillful in both languages before the age of 5 years.

### *Autism*

Autism is a developmental disorder based on neurological issues. It is categorized by difficulties in social interaction, verbal and nonverbal communication, and repetitive behaviors.

The Characteristics of ASD are an intellectual disability, delayed and deviant language development, difficulties in motor coordination, planning, attention, and physical health issues such as sleep and gastrointestinal disorders. They also have compulsive behaviours, including stereotyped repetitive motor activity. Other speech disorders, such as echolalia and pronoun reversal, are also seen in these children. Children with autism have an atonic, wooden, or sing-song quality of speech. These children fail to make eye contact, smile socially and have issues responding to being hugged or using gestures to communicate. Some persons with ASD outstand in extracurricular activities such as visual skills, music, math, and art. Autism appears in the very early stage of brain development. However, the most obvious signs and symptoms of autism tend to be noted between two and three years of age.

### *Cerebral palsy (CP)*

Cerebral palsy (CP) is a kind of motor impairment in children, affecting about two children per 1000 live births (Stanley & Watson, 1992; Himmelmann, Hagberg & Uvebrant, 2010). Cerebral palsy is a covering term that refers to a class of disorders considered by non-progressive impairments in movement and posture that are acquired early in life due to a brain abnormality (Bax, 1964; Mutch et al., 1992). The etiology of CP is very diverse and multifactorial. The causes are congenital, anoxic, infectious, inflammatory, metabolic, and traumatic. The damage to the evolving brain may be prenatal, natal, or postnatal. So far as, 75-80 per cent of the cases are due to prenatal injury, with less than 10% being due to significant birth trauma or asphyxia (MacLennan A, 1999). The significant threat factor is prematurity and low birth weight.

An athetoid type of cerebral palsy mostly results in speech delay. The speech delay may be due to hearing loss, spasticity of the tongue muscles, defect in the cerebral cortex, or parallel mental retardation.

***Cleft Lip/Palate***

A cleft that cracks that occur in the palate and lip are one of the common congenital disabilities in children. This happens in around one in 700 births. A cleft lip and palate is nothing but the imperfect closure in the roof of the mouth or at the upper lip, which causes a gap or defect to occur in the affected area, involving skin, muscle, and the layer of the mouth. There is often an associated deformity of the nose on the affected side.

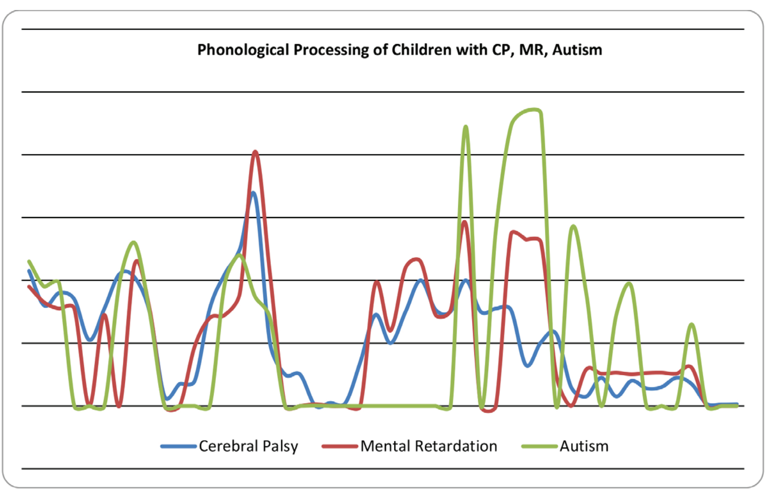
A cleft lip is unilateral if it is on one side of the upper lip and bilateral if it is on both sides of the upper lip. A cleft lip can occur alone or can occur with a cleft palate. Likewise, a cleft palate may occur in isolation without a corresponding upper lip deformity.

Children will have speech difficulties if the cleft palate is not repaired. Surgery has to be done to gain normal speech. After the surgery, many children will need speech therapy, and some may require a second procedure if speech issues continue. The speech therapist will regularly assess speech development and arrange for speech therapy in the community if necessary.

### ***4.2.1. Phonological Process variation due to various disorders in Assessment***

For the current study, Children with Mental Retardation, Cerebral Palsy, and Autism were taken as samples according to the availability of the disordered population. Fifty children with cognitive delay, thirty with cerebral palsy, and twenty with Autism were divided into five groups with twenty children each. They have variations in their language issues due to the difference in the disorders.

All these children have a delay in their life skills development, like social skills, communication skills, and adaptive skills. These children were not able to communicate fluently in society through their speech because of their low cognitive function and poor knowledge of their phonotactics. However, they need proper pronunciation to have successful communication with others. Before planning the speech remedies for these children, a proper assessment and analysis are needed. Though all these children have commonness in processing, they also have marked features according to their disorders. The phonological process of these children in earlier studies exhibits commonness in the processing, but the percentage of occurrence shows quite interesting variation.




Graph 1: Shows the percentage phonological process of children with MR, CP, and Autism

Table 17: Shows the percentage phonological process of children with MR, CP, and Autism

| | Phonological Processes | | | CP Kala & Lalitha (2016) | MR Sasipriya & Lalitha (2016) | AUTISM Avvai & Lalitha (2016) |
|---|---|---|---|---|---|---|
| 1. | SUBSTITUTION | Stopping | Fricative stopping | 4.3 | 3.8 | 4.6 |
| 2. | | | Liquid stopping | 3.2 | 3.3 | 3.8 |
| 3. | | | Glide stopping | 3.6 | 3.1 | 3.9 |
| 4. | | Fronting | Palatal fronting | 3.4 | 3.1 | 0 |
| 5. | | | Alveolar fronting | 2.1 | 0 | 0 |
| 6. | | | Dental fronting | 3.1 | 2.9 | 0 |
| 7. | | | Velar fronting | 4.2 | 0 | 3.9 |
| 8. | | | Retroflex fronting | 4.1 | 4.5 | 5.2 |
| 9. | | | Vowel fronting | 3 | 3.1 | 3 |
| 10. | | Backing | Bilabial | 0.3 | 0 | 0 |
| 11. | | | Alveolar | 0.7 | 0 | 0 |
| 12. | | | Retroflex backing | 0.8 | 1.9 | 0 |
| 13. | | | Dental backing | 3.1 | 2.8 | 0 |
| 14. | | | Palatal backing | 4.2 | 2.9 | 3.9 |
| 15. | | | Vowel backing | 5 | 3.6 | 4.8 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 16. | SUBSTITUTION | Gliding | Stop gliding | 6.7 | 8.1 | 3.49 |
| 17. | | | Liquid gliding | 2 | 4.2 | 2.8 |
| 18. | | Liquiding | Glide liquiding | 1 | 0 | 0 |
| 19. | | | Stop liquiding | 1 | 0 | 0 |
| 20. | | | De-nasalization | 0.01 | 0.06 | 0.01 |
| 21. | | | Prevocalic voicing | 0.1 | 0 | 0 |
| 22. | | | Post vocalic voicing | 0.09 | 0 | 0 |
| 23. | | | Fricativization | 1.4 | 0 | 0 |
| 24. | | Duration | Monophthongization | 2.9 | 3.9 | 0 |
| 25. | | | Diphthongization | 2 | 2.4 | 0 |
| 26. | | | Shortening | 3 | 4.4 | 0 |
| 27. | | | Lengthening | 4 | 4.6 | 0 |
| 28. | | Height | Vowel rising | 3.06 | 2.9 | 0 |
| 29. | | | Vowel lowering | 3.01 | 3.06 | 0 |
| 30. | SYLLABLE STRUCTURE PROCESS | Segment Deletion | Initial consonant deletion | 4 | 5.8 | 8.9 |
| 31. | | | Medial consonant deletion | 3 | 0 | 0 |
| 32. | | | Final consonant deletion | 3.1 | 0 | 5.6 |
| 33. | | Syllable Deletion | Initial syllable deletion | 3.06 | 5.46 | 8.9 |
| 34. | | | Medial syllable deletion | 1.3 | 5.3 | 9.4 |
| 35. | | | Final syllable deletion | 2.03 | 5.2 | 9.3 |
| 36. | | Cluster Reduction | Initial cluster reduction | 2.3 | 1 | 0 |
| 37. | | | Medial cluster reduction | 0.6 | 0 | 5.6 |

| | | | | | |
|---|---|---|---|---|---|
| 38. | ASSIMILATION | Bilabial assimilation | 0.3 | 1.16 | 3.6 |
| 39. | | Nasal assimilation | 0.9 | 1.03 | 0 |
| 40. | | Dental assimilation | 0.3 | 1.06 | 2.9 |
| 41. | | Retroflex assimilation | 0.8 | 1.01 | 3.8 |
| 42. | | Palatal assimilation | 0.56 | 1.05 | 0 |
| 43. | | Velar assimilation | 0.6 | 1.06 | 0 |
| 44. | | Alveolar assimilation | 0.9 | 1.03 | 0 |
| 45. | | Lateral assimilation | 0.7 | 1.22 | 2.6 |
| 46. | | Glide assimilation | 0.07 | 0 | 0 |
| 47. | | Metathesis | 0.05 | 0 | 0 |
| 48. | | Reduplication | 0.06 | 0 | 0 |

## 4.3. Earlier Studies in the Assessment of Phonological Disorders (PD)

### *4.3.1. Methods Commonly Followed for the Assessment*

Commonly the speech disorder is analyzed by using two different primary analysis methods. Under that, some sub-analysis methods are there. They are given below.

**a. Phonological process analysis (PPA)**

This approach analyses how a child simplifies an adult target form of a word. Much of the research concerning phonological processes has focused on disordered articulation and various analysis methods. Phonological Process can be classified as (described in-detail in the introductory chapter) according to Ingram's (1981) system, which includes syllable structure processes, substitution processes, simplification of liquids and nasals, other substitution processes, and assimilation (or harmony) processes. Similarly, Elbert and Geirut (1986) describe three basic types of process deviations: a process that deletes segments, processes that substitute segments, and processes that assimilate segments.

**b. Distinctive feature analysis (DFA)**

Distinctive feature theory was initially described by Jakobson, Fant, and Halle (1952) and then elaborated by Chomsky and Halle (1968), which has been used to describe phonological development as a rule-governed behavior.

The use of distinctive features in phonology enables to capture of 'natural classes'. The distinctive feature is the most basic unit of phonological structure. The extension is to generalize regularly occurring phenomena and to formulate predictions about the behavior of class members.

Many eminent scholars have worked on distinctive features. Trubetzkoy (1939) attempted a comprehensive taxonomy of the phonetic properties of the distinctive contrasts employed by languages. He was interested in how /p/ differs from /b/, and the nature of contrast within a given phonological system. He classified distinctive oppositions based on three rules.

1. The relationship of the entire system of oppositions.
2. Relationship of the opposition members.
3. The extent of their distinctive force.

Trubetzkoy (1939) revealed how the same phonetic contrast might structure differently in different languages. Depending on the system, a given opposition may be privative in one language but gradual in another.

Various sets of distinctive features have been proposed as the parameters of segment description and classification. The original set that appeared in Jokobson, Fant, and Halle (1952) proposes that contrast oppositions are merely surface phonetic realizations of the same underlying feature of flatness. They hypothesized that a limited number of such features say 12 to 15, account for all the oppositions in the world's languages. Since more than 12 to 15 phonetic features are necessary to differentiate the various sounds occurring in languages, it becomes apparent that some of these phonetic features will be "conflated" into the more limited set of phonological or distinctive features. The 12 to 15 distinctive features are classified into six types. They are listed below:

1. Major class features
   a. Syllabic
   b. Sonorant
   c. Consonantal
2. Manner features
   a. Continuant
   b. Delayed release
   c. Strident
   d. Nasal
   e. Lateral
3. Place of articulation features
   a. Anterior
   b. Coronal
4. Body of the tongue feature
   a. High
   b. Low
   c. Back

   d. Lip Shape feature : Rounded
5. Subsidiary features
   a. Tense
   b. Voiced
   c. Aspirated
   d. Glottalized
6. Prosodic features
   a. Stress
   b. Long

These are the standard distinctive features for all the language phonemes the great western scholars mentioned. Recently, distinctive feature theory has also provided a framework for understanding misarticulations. Menyuk (1968) presented data showing that distinctive feature theory could be used to describe the phonological system of a child with articulation problems. In his book *Phonological Disability in Children*, Ingram (1976) discussed several children's misarticulations in terms of the phonological processes they used. He provides much detail on the systematic nature of deviant phonology.

**c. SODA processes**

In attempting to classify disordered speech at the segmental level, segmental phonology provided a way to distinguish between errors that resulted in exchanging one contrastive unit (i.e., phoneme) of the target sound system with another.

When producing speech sounds, a child may make the following articulation errors. They are Substitutions, Omissions, Distortions, and Additions. A quick way to remember these is to use the acronym SODA (Van Riper, 1963; Grunwell, 1987).

S – Substitutions: Replace one sound with another sound. Examples: "wed" for "red," "thoap" for "soap," "dut," for "duck"

O – Omissions /deletions: Omit a sound in a word. Note: This error affects intelligibility the most, making speech more difficult for the listener(s) to understand. Examples: "p ay the piano" for "play the piano", "g een nake" for "green snake"

D – Distortions: Produce a sound in an unfamiliar manner.

Examples: “pencil” (nasalized—sounds more like an “m”) for “pencil,” “sun” (lisped—sounds “slushy”) for “sun”

A – Additions: Insert an extra sound within a word. Examples: “bulack horse” for “black horse,” “dogu,” for “dog”

**d. Place Voice Manner analysis /PVM analysis**

This analysis describes error patterns in terms of three broad categories of consonant production (P-V-M). It is similar to phonological process analysis. A form with a column for Place Voice and Manner is prepared, and the analysis is completed on PVM Analysis Form. So, complete whole-word transcriptions must be done before analysis, and use black/red markers to color code. Then the evaluator must mark each consonant with the appropriate colour in the box on the PVM form and list the child’s phonetic inventory. Then the error patterns according to PVM have to be summarized. The disadvantage of this analysis is that it does not identify assimilation errors.

So the two important and efficient analysis methods for phonological disorders are PPA and DFA.

### *4.3.2. Western Stusies on Phonological Processes in Various Clinical Populations*

**a. Cerebral palsy**

Byrne (1959) indicated that children with cerebral palsy produced vowels more accurately than consonants. It was shown that consonants in the medial and final positions were the most difficult, whereas Irwin (1972) reported that voiced consonants were produced more accurately than unvoiced consonants, and nasal sounds were the most accurate, with fricatives and glides being less accurate. Among vowels, the mid and low front vowels were produced more accurately than high vowels and vowels with lip rounding. The bilabial place of articulation was more accurate for consonants than lip complex and tongue tip complex sounds.

Laing (1979) investigated a left hemiplegic child with the impairment of the speech musculature to find whether the dysarthric errors resulted from an articulatory or phonological disorder. The speech sample was subjected to independent transcriptions by three transcribers. The data was analysed regarding a natural phonological analysis determining the processes operating in the subject's speech to affect all single consonants and initial consonant clusters. Results indicated that the phonological system of the subject was systematic and rule-governed and that the processes operating upon the phonological systems were attributable only in part to the deviant speech musculature.

Platt et al. (1980 a,b) described speech errors and speech intelligibility in 50 adult males with cerebral palsy (32 spastics and 18 athetoid). Error patterns were determined by the construction of confusion matrices for each speech segment based on a phonetic transcription of 29 single words. The central findings for speech errors were that consonant errors were predominantly with-in manner (i.e., errors of place or voicing). They concluded that dysarthric adults had phonemic competence but lacked articulatory precision. Manner errors accounted for the simplification of the articulatory task. Similar error patterns were found for word-initial and final consonants. Athetoid speakers performed less than speakers with spastic-type cerebral palsy on all speech measures. However, analysis of error patterns showed that the differences were more of severity than type.

Whitehill and Ciocca (2000) studied to characterize the speech errors made by Cantonese-speaking adults with dysarthria associated with cerebral palsy using a perceptual phonetic analysis. The subjects were 22 adult Cantonese speakers with cerebral palsy; 15 subjects had spastic-type cerebral palsy, 5 had an athetoid type, and two had a 2-mixed type. Single words were transcribed phonetically. They are analysed using speech analysis for accuracy and error patterns. There were no significant differences in accuracy for the type of cerebral palsy, gender, or age. Speakers with athetosis significantly had more occurrences of diphthong reduction. The neurological damage of cerebral palsy could explain the majority of error patterns. However, several patterns were attributed to unique features of the Cantonese phonological system. The features of Cantonese phonology which appeared to influence the error patterns shown by this group of speakers included tone, the small fricative system, the high relative occurrence of affricates, the final stop system, and the monophthong vowel system. Substitution errors were more common than distortions, challenging the traditional view of dysarthria as being characterized by distortion errors. These results provide information that is of clinical relevance to the assessment and management of Cantonese speakers with cerebral palsy and provides a foundation for further research in this area.

**b. Mental retardation**

Several studies have reported that the articulatory abilities of Down's syndrome children are poor, but have provided little detail on the nature of the articulation problem. Carol Stoel-Gammon (1979) analysed the phonological process of four Down's syndrome children. This research presents a phonological analysis of the spontaneous speech of four Down's syndrome children, ages 3;10–6;3 including a) the phonetic inventory of each subject, b) a comparison of target consonant phonemes and the subjects' renditions of these phonemes, and c) characterization of the subjects' errors in terms of phonological processes. The findings indicate that 1) although the subjects are capable of producing nearly all the consonant phonemes, correct production is often limited to a particular position within the word, 2) the phonological processes which account for the errors of the Down's syndrome subjects are similar to those reported for normal young children, and 3) the phonological abilities of the four subjects are comparable to, or better than, their general language ability as measured by MLU.

A study on—Phonological process identification of misarticulation of mentally retarded children by Linda Mackay and Barbara Hodson (1982) collected data from 20 mentally retarded children between the ages of 6;4 yearsand 15 years. The study states that liquid deviations and cluster reductions were the most prevalent phonological processes evidenced in their misarticulation. Postvocalic obstruent omissions, deviations of other sonorants (glides and nasals), velar deviations, stridency deletion, stopping, and /θ,/ deviations were demonstrated less frequently. In addition, the children demonstrated pre- and postvocalic devoicing.

Becker (1982) studied 10 Spanish-speaking children of four years range and found that de-affrication, /r/ deficiencies, cluster reduction, epenthesis, weak syllable deletion, and alveolar assimilation were frequently occurring processes in these children.

Mackay L et al. (1982), in their study on phonological process identification of mis-articulations of children with mental retardation, studied the speech samples of 20 mentally retarded children between the ages of 6;4, and 15 years and were analysed for the purpose of identification of systematic patterns. Liquid deviations and cluster reductions were the most prevalent phonological processes evidenced in their misarticulations. Postvocalic obstruent omissions, deviations of other sonorants (glides and nasals), velar deviations, stridency deletion, stopping, theta, and sigma deviations were demonstrated less frequently. In addition, the children demonstrated pre- and postvocalic devoicing.

R.J. Prater et al. (1982), in their study on functions of consonant assimilation and reduplication in early word productions of children with mental retardation, studied the spontaneous speech samples from eight mentally retarded children. Examples of consonant assimilation and reduplication found in their speech samples were separately analysed to examine how these phonological processes function in the phonologies of children with mental retardation. Results showed wide individual variability in subjects' use of consonant assimilation. Reduplication provided a method by which the subjects could produce multisyllabic targets and /or a method by which the subjects could produce multisyllabic words with one syllable containing target consonants of consonant clusters absent from their phonetic repertories.

M. J. Moran, et al. (1984), in their study on phonological process analysis of the speech of adults with mental retardation, phonological process analysis performed on the speech of 20 mentally retarded adults. Results indicated that these subjects exhibited deletion of final consonant, cluster reduction, weak syllable deletion, and stopping. These processes are similar to those previously reported for children with mental retardation and unintelligible non-retarded children. Differences between subjects classified as moderately and severely retarded appear to be quantitative rather than in the type of process exhibited.

Another study with three-year-old Spanish children by Martinez (1986) revealed tap/trill deficiencies, consonant sequencing reduction, de-affrication, stopping, affricate, fronting, assimilation, and sibilant distortion.

According to the author, the phonological patterns coincide broadly with universal tendencies, although some language-specific patterns were also evident. The same findings were also reported in the study by Boboleni and Leonard (2000) in the Italian language.

Topbas (1997) studied the phonological acquisition in Turkish children and reported that Turkish/l/ was substituted by /r/, i.e., a liquid realization of another liquid, whereas, in English /r/ is usually replaced by /w/ or /j/ a gliding process.

**c. Autism**

Some children with ASD do not acquire phonemes in the developmentally typical order. Their phonemic inventories may include later developing sounds while earlier sounds are absent, termed a chronological mismatch (Grunwell, 1981).

Bartoluccil, Piercel, Streinerl, and Eppell (1976) studied phonological investigations of verbally autistic and mentally retarded subjects that exposed phoneme acquisition delay. The consistency of error types was found in both groups. However, the autistic subjects differed significantly from the mentally retarded in the phonemic substitutions.

Wolk, L, and Edwards, M.L. (1993) studied the phonological processes of an autistic child who was eight years old. Three approaches were used to evaluate speech: delayed imitation, object naming, and connected speech sample. Phonetic inventory analyses revealed that stops, nasals, and glides were present, whereas fricatives, affricates, and liquid /r/ were absent. For instance, the phonemic inventory of the child in Wolk and Edwards

(1993) contained the voiced phonemes /z/ and /ʒ/, but the voiceless counterparts /s/ and /ʃ/ were absent. In normal development, the voiceless /s/ and /ʃ/ are acquired prior to their voiced counterparts (Wolk & Edwards, 1993).

Wolk and Giesen (2000) found three of four autistic siblings to demonstrate a chronological mismatch. Thus, the phonological development of children with ASD cannot be described simply as a developmental delay, as it does not necessarily follow the typical developmental pattern.

Cleland, Gibbon, Peppe, O'Hare, and Rutherford (2010) also found that some children with ASD produce non-developmental phonemic errors. The study characterized the main developmental phonological processes (gliding, cluster reduction, and final consonant deletion most frequently) of children with ASD. They found that some children with ASD backed phonemes, labialized and prolonged phonemes, and palatalized phonemes. Moreover, two children in their study produced /s/ and /z/ with nasal emission. This phonemic error is non-developmental and is rarely found in children with phonological or phonetic disorders (Cleland et al., 2010). As these sounds are not characteristic of typically developing children, it seems that the phonology of children with ASD contains non-typical deficits.

In his study, Pia M. Nordgren (2015) declares that sound production is progressing both quantitatively and qualitatively. The development was seen in the new syllable constructions, the use of new phonological feature types, and new words during the year. The delayed and abnormal speech development concerning segments, syllables, and word boundaries in this child is in line with studies that describe an atypical phonological development in individuals with autism.

**d. Other clinical population**

Bodine and Smith (1974) studied phonological processes in the speech of Down syndrome children. They identified the following as occurring most frequently cluster reduction, assimilation (nasal, labial, and velar) fronting, final constant deletion, stopping, vocalization, liquid deletion, and gliding. Also, these children revealed unusual processes but were not of high frequency.

Oller and Kelly (1974) investigated the generative framework of the phonological substitution processes of a six years old child with severe sensorineural hearing loss. The child's substitutions had much in common with the substitution of younger normal children. For instance, liquid consonants were replaced by glides and rounded vowels, final fricative consonants were devoiced, and consonants were shifted to more forward places of articulation as would be observed in normal children.

Hodson and Paden (1981) studied the phonological systems of 60 "unintelligible children" between the age of three and eight years, and 60 normally developing "intelligible children" four-year old's were analysed and compared. The assessment of the phonological process (Hodson, 1980) was administered individually to all subjects. Children have to name 55 common objects, body parts or simple concepts. All the unintelligible children evidenced liquid deviations, cluster reduction, stridency deletion, stopping, and assimilation. Liquid deviations were demonstrated by some of the intelligible children. However, most produced liquids roughly, and few demonstrated cluster reduction, stridency deletion, or stopping. Many unintelligible children used one or more processes like final consonant deletion; fronting of velars, backing, syllable reduction, prevocalic voicing; glottal replacement. The intelligible children of four years old rarely utilized any of these processes. Rather than postvocalic devoicing, substitutions of / f v s z / for /θ/ or /ŏ /; and vowelization of prevocalic or syllable /l/ were common in their speech samples.

Lauko et al. (1990) compared the phonological processes exhibited by children who were stutterers and their normally fluent peers and related these phonological processes to typical measures of stuttering and other speaking variables. Totally 60 children were taken and divided into two groups. The first group consisted of 30 normally fluent children, and the second group of 30 children diagnosed as stutterers. Both the groups were matched for age and sex, with a mean age of 4;6 years. Each child of both groups was audio and videotaped while they were informally interacting with their mother. The mother was instructed to talk and play as they would at home, using a specific set of toys, objects, and pictures. Results indicated that children who stutter were more likely to exhibit speech-sound errors than their normally fluent peers, and they exhibited 18 different phonological processes, while the normally fluent group exhibited only 11 processes. Results of the second part of the study indicated that children who stuttered were significantly more likely to be described as having disordered phonology than their normally fluent peers.

Pollack and Keiser (1990) studied vowel errors in phonologically disordered children. The speech of 15 phonologically disordered children between the ages of 3;08 years, and 6;04 years were analysed for the presence of vowel errors. Speech samples comprised single-word responses to objects, pictures, actions, body parts, colors, and locative positions. Words were selected to provide multiple opportunities for the production of each English vowel and diphthong in various word shapes and phonetic contexts. The percentage of vowels correctly produced was calculated for each subject. Fourteen subjects produced errors on rhotic vowels and diphthongs. A wide range of scores was found on non-rhotic vowels. One subject showed consistent errors on several vowels. Of the remaining subjects, some showed little difficulty with vowel production, while others showed occasional errors on several vowels or a more consistent error on an infrequent or later developing vowel/diphthong.

Ashley, K.H. (1995) investigated phonological processing in children with speech disorders. The study compared the speech errors of two groups of children on four tasks: naming, repetition of the sentence, repetition of non-words, and words. Twenty-seven Cantonese-speaking children aged from 4;5 years to 6;5 years participated. Results indicated a significantly higher percentage of phonemic errors for the phonological disorder group than for the delayed group. Similar performance was seen in both groups across the four tasks.

Leitao, Hogben, and Fletcher (1997) studied phonological processing skills in speech and language-impaired children. Subject selection was employed to compare the performance of four different age groups of 20 children aged approximately six years: speech-impaired (speech); language-impaired (language); speech and language impaired (mixed); and children with normal language (Normal); using a battery of phonological processing tasks. All the subjects in this sample appeared to be at risk; the mixed children demonstrated most difficulty, followed by the language group, with the normal performing the best. While the speech group as a whole performed significantly more it performed poorly than the normal group. The results supported the research showing that speech and language-impaired children have weaker phonological processing skills than the general population.

Peter and Rhonda (2008) studied phonological patterns in the conversational speech of children with cochlear implants. Phonological patterns were examined in conversational speech samples from six children fitted with cochlear implants. Both developmental and non-developmental patterns were observed. Results indicated that the commonly occurring developmental pattern was stopping-initial, with an average frequency of 36.8 per cent. Regressive assimilation was the least commonly occurring developmental pattern, with an average frequency of only 0.1 per cent. The most common non-developmental pattern was vowel substitution with an average frequency of 2.4 Per cent. The least commonly occurring non-developmental pattern was glottal stop substitution-initial, which never occurred in any of the 40 transcripts (0%). The study concludes with the consistent findings from previous studies on the speech of children with hearing loss who wear hearing aids.

To provide effective intervention for children with specific language impairment (SLI), it is crucial that there was an understanding of the underlying deficit in SLI. Claessen, Suze Leit, Kane and Williams (2013) studied phonological processing skills in specific language impairment. This study utilized a battery of phonological processing tasks to compare children's phonological processing skills with SLI to typically developing peers matched for age or language. The children with SLI had significantly poorer performance than age-matched peers on measures of phonological representations, phonological awareness, rapid automatized naming, phonological-short-term memory, and one measure of working memory. Of particular significance, the SLI group also demonstrated significantly weaker performance than language-matched peers on one measure of phonological representations and one measure of working memory. The findings support a phonological processing account of SLI and highlight the utility of using tasks that draw on a comprehensive model of speech processing to profile and consider children's phonological processing skills in detail.

### *4.3.3. Indian Literature on Phonological Processes in Clinical Population*

#### a. Cerebral Palsy

Lakshmi (2001) studied the speech of adults with cerebral palsy using phonological processes analysis. The study subjects were twelve Tamil-speaking adults with spastic cerebral palsy, aged 17- 26 years. All of them were ers. Speech samples were elicited using pictures of the Tamil Articulation Test (Usha, 1986) and picture story sequences of a common Panchatantra story. The results indicated the occurrence of fronting, stopping, gliding of liquids, devoicing, vocalization, final consonant deletion, initial consonant deletion, backing, and vocalic support of final consonant and consonant harmony in cerebral palsied subjects. Of these, fronting, final consonant deletion, and gliding of liquids occurred in a higher percentage of words than other processes. A traditional sound-by-sound analysis revealed more substitution errors, followed by omissions, distortions, and additions in that order. The phonological process analysis pointed to the economy of using such an approach compared to the traditional sound-by-sound analysis for describing and intervening dysarthria in adults with cerebral palsy.

A similar study described the speech of Telugu-speaking children and adults with spastic cerebral palsy (Eemani, 2002) and tested the assumption of stability of articulatory errors from childhood to adulthood at the phonemic level of accuracy and phonological processes. 18 Telugu-speaking spastic cerebral palsy subjects were divided into two groups. One group consisted of 9 children aged five to ten years, and the second group consisted of 9 adults aged 17-30 years. Results indicated that substitution errors were around 60 per cent, and Omission and distortion were 3.5 per cent. Children and adults had fronting, backing, and stopping errors. Children had greater errors than adults (29.33 %, and 14%, respectively). These findings implied the neuromotor basis of speech and therapeutic intervention for a person with cerebral palsy.

Kala Samayan and Lalitha Raja (2016) analyzed phonological processes in Tamil-speaking children with spastic cerebral palsy. Fifteen children with cerebral palsy aged eight to thirteen years and fifteen typically developing Tamil-speaking children aged three to six years participated in the study. These children were assessed with the Tamil articulation test (Dalvi, 1986), and speech samples of each child were transcribed using International Phonetic Alphabet (IPA ext, 2005). Results indicated that 16 phonological processes were observed in spastic CP children. Among these, final consonant deletion, syllable reduction, cluster simplification, and stopping were more frequent than other processes. In normal children, a total of 13 phonological processes were identified. These 13 processes included final consonant deletion, syllable reduction, cluster simplification, stopping, backing, palatalization, lateralization, and nasal assimilation.

**b. Mental retardation**

Anita, A.P.D. (2002) studied the development of phonological processes in Tamil-speaking mentally retarded children. She found features like final consonant deletion, cluster reduction, weak syllable deletion, and stopping in their speech.

Vani Rupelaa, R. Manjulab and Shelley L. Velleman (2009) studied phonological processes in Kannada-speaking adolescents with Down syndrome. Phonological process analysis was carried out using a 40-word imitation task with 30 children aged 11; 6 to 14; 6 year old Kannada-speaking persons with Down syndrome in comparison with 15 non-verbal mental age-matched typically developing children. Percentages of occurrence were significantly higher for the Down syndrome group, with certain exceptions. Some phonological processes were observed only in the Down syndrome group. Kannada is a non-Indo-European language spoken in the southern Indian state of Karnataka that has not had much research attention, especially with respect to persons with communication disorders. This paper highlights the phonological processes observed in school-aged persons with Down syndrome, some of which are similar to those observed in English and Dutch (cluster reduction, stopping, gliding, consonant harmony) and others that differ owing to differences in Kannada's phonology (e.g. retroflex fronting, degemination). The study gives a cross-linguistic perspective to the study of phonological processes in Down syndrome.

Sasipriya and Lalitha Raja (2014) identified the phonological problem in obstruent sounds of children with mental retardation in their mother tongue (Tamil). This study analyses the phonological processes in obstruent sounds of 20 children with mental retardation by using the distinctive feature analysis. The study also recommends the sound features that should be concentrated for remedial measures.

Sasipriya and Lalitha Raja (2015) documented the phonological deviances in Tamil's sonorant sounds of children with mental retardation. This study analyzed the phonological processes in obstruent sounds and also used distinctive feature analysis. The study also recommended the sound features that should be concentrated for remedial measures.

**c. Autism**

Avvai Azhagammai, and Lalitha Raja (2015) studied the phonological process of Tamil children with Autism and documented 17 processes, and the results revealed deletions were seen more in consonant and syllable level.

**d. Other clinical populations**

Sneha (1994) compared the phonological processes of three to seven-year-old Kannada speaking children who stutter with their normally fluent peers. The speech samples of these children were obtained using Kannada Articulation Test and picture description task. The results indicated that Kannada articulation elicited some processes than the picture description tasks. The young people who stutter were found to exhibit more varieties and number of processes than their fluent peers. The frequency and per cent occurrence of these processes were also high in the young stutterers than in their fluent peers. Further, ten phonological processes: stopping, frication, multiple processes, lateralization, depalatalization, the substitution of glide, epenthesis, interchange of the place of articulation, diminutivization, and change in place of articulation were identified that were specific to stutterers and not seen in normal children. Among these, stopping, fricativization, and lateralization were deviant phonological processes.

Upasna (1999) studied phonological processes in Hindi-speaking children with Hearing Impairment. The subjects selected were 14 children with Hearing Impairment in the age range of nine to thirteen years, whose mean age was ten years seven months. Out of the 14 children, six had profound hearing loss, and eight had severe hearing loss. The test materials were selected from Photo Articulation Test in Hindi. The results indicated the occurrences of deletion, assimilation, cluster reduction, deaffrication, devoicing of final consonants, deaspiration, denasalization, labialization, backing, stopping, palatalization, deletion of initial consonants, and deletion of final consonants.

Harneesh (2001) compared the phonological processes in the speech of a child with developmental apraxia of speech (aged six years three months) and an age and gender-matched normal child. Speech samples were elicited in a play situation for 90 minutes and later transcribed to analyze the phonological processes. Results revealed that the normal child exhibited phonological processes such as fronting, backing, assimilation, metathesis, cluster reduction, stopping, gliding, denasalization, and aspiration, whereas the child with apraxia exhibited normal as well as unusual phonological processes. Normal processes that were exhibited by the child with Developmental Apraxia of speech were syllable deletion, stopping, devoicing, fronting, vocalization, lateralization, cluster reduction, reduplication, voicing, gliding, and palatalization. Unusual processes included initial consonant deletion, denasalization, nasalization, vocalic support for final consonant, initial consonant adjunction, and dentalization. The frequency of occurrence of phonological processes was observed more in the child with Apraxia compared to a normal child.

Ramadevi (2006) did a study to profile the phonological processes in normal Kannada-speaking children and also in Kannada children with HI. The phonological profile developed in Kannada was used for the phonological assessment of children. It incorporates three tasks. All three tasks, task – 1 (picture cards), task – 2 (written words), and task – 3 (story charts), were administered to 30 normal children (Group -1) and 30 hard-of-hearing children (Group – 2). Results showed 29 common phonological processes (Cluster reduction, Deaspiration, Denasalization, Devoicing, Fronting, Vowel backing, Vowel lowering, etc.) were found in normal as well as hearing-impaired children. However, the percentage of phonological processes and the total number of processes observed in the hearing impaired were more compared to the normal group.

A study by Patlolla, Nageshwar, Venkatesh, Lakshmi, Ravindra, and Swathi (2012) deals with the Phonological Process Analysis in Telugu-speaking children with dyslexia. Thirty Telugu-speaking children (15 children with dyslexia and 15 typically developing children) were used for the study. Speech samples elicited from children with the help of picture cards of Telugu Test of Articulation and Phonology were subjected to the phonological process analysis method. Children with dyslexia continued to demonstrate phonological processes in their speech even beyond six years of age. Compared to typically developing children, most children with dyslexia showed the presence of processes in syllable structure, substitution, and assimilation processes. The observation of the presence of phonological processes in the speech of Telugu-speaking children with dyslexia, even at the age of six and a half years, are consistent with the findings of persisting phonological inaccuracy and processes among children with reading difficulties.

Kala and Akila (2015) investigated a comparative study of phonological processes in Tamil-speaking typically developing vs. ADHD children. The phonological processes in Tamil-speaking children with ADHD aged seven to 12 years were analysed and compared with the normal children in the age range of three to six years. Results showed that 22 phonological processes occurred among ADHD children and only ten processes in normal children. Among these, syllable structural processes were more in number than the other two categories of substitution and assimilation. Overall, children with a lower language age demonstrated some processes than children with a higher language age performance. A higher number of processes observed in children with ADHD might be because of their inattention, hyperactivity, impulsivity, and developing language skills. Younger children showed more percentage of occurrences than older children.

From the reviews done on earlier studies, it is inferred that studies on speech impairments in autism are very few and scarcely found in an Indian study.

## 4.4. Assessment using OT

### *4.4.1. Constraints in Tamil Phonological Disorders*

The patterns in disordered phonology of Tamil children with disorders MR, CP, and Autism show all the universal patterns of phonological processing as seen in typically developing children and also markedness. The constraints of phonological deviance in Tamil children must be found using OT.

#### *4.4.1.1. Analysis of error patterns using OT*

The error patterns of the children with CP, MR, and Autism have been discussed here as in the previous chapter on phonological acquisition under various error patterns like; deletion, substitution, assimilation, metathesis, and cluster simplification. All those have their further sub-classifications like:

Deletion – segment (consonant, vowel, and diphthong) and syllable deletion

Substitution – backing, stopping, fronting, gliding, liquiding, height positioning, duration shift, denasalization, voicing (prevocalic and postvocalic), fricativization

Cluster simplification – Reduction, Epenthesis, Coalescence.

The description for the analysis of the error patterns is very briefly given as it is as same as the description of the error patterns of phonological acquisition in the chapter.

### A. Deletion / Syllable Structure Processes

Deletion happens in two levels in these children's phonology regarding segments and syllables. These processes are termed Syllable Structure Processes in phonological processing.

#### a. Segment Deletion

Consonant, vowel, or diphthong segment deletions occur in children's speech, such as /cɑ:ppɑ:ʈu/ > /ɑ:ppɑ:ʈu/ is seen as **initial consonant deletion**, /kɑ:ɾɑm/ > /kɑ:ɑm/ is seen as **medial consonant deletion,** /n̪ɑɳpɑn/ > /n̪ɑɳpɑ/is seen as **final consonant deletion,** /uɾɑl/ > /ɾɑl/ is seen as **initial vowel deletion,** and /ɑ:mɑi/ > /ɑ:m/is seen as **final diphthong deletion.**

These patterns reflect the ranking of the markedness constraint *ONSET ("no initial consonants") for /cɑ:ppɑ:ʈu/ > /ɑ:ppɑ:ʈu/ and /kɑ:ɾɑm/ > /kɑ:ɑm/, *CODA, ("no final consonants") for /n̪ɑɳpɑn/ > /n̪ɑɳpɑ/and *NUCLEUS, ("no vowel/diphthong") for /uɾɑl/ > /ɾɑl/ and /ɑ:mɑi/ > /ɑ:m/ over the faithfulness constraint MAX ("no deletion"). The conflict between the markedness (*ONSET, *CODA, and *NUCLEUS) and faithfulness constraints (MAX) and their violability by different output forms are shown in the following constraint tableaus.

##### *i. Initial Consonant Deletion*

The deletion of the segment /c/ is the onset of the first syllable of the word /cɑ:ppɑ:ʈu/. So the markedness constraint is ONSET, and the faithfulness constraint is MAX.

**(80)** Initial voiceless palatal consonant (c) is deleted in a word**.**

| /cɑ:ppɑ:ʈu/ 'food' | ***ONSET** | **MAX** |
|---|---|---|
| a. [cɑ:ppɑ:ʈu] | *! | |
| b.☞[ɑ:ppɑ:ʈu] | | * |

**(81)** Medial voiceless alveolar tap /ɾ/ (Initial Consonant of second) syllable is deleted.

| /kɑ:ɾɑm/ 'hot/spicy' | ***ONSET** | **MAX** |
|---|---|---|
| a. [kɑ:ɾɑm] | *! | |
| b. ☞[kɑ:ɑm] | | * |

Though the deleted consonant /ɾ/ occurs in the middle of the word /kɑ:ɾɑm/, according to the syllable division, the word can be syllabicated as /kɑ:ɑm/. So the deletion of the segment /k/ happens at the onset of the second syllable of the word. So the analysis using OT for this utterance can be done the way it has been done for the previous word. So, this pattern reflects the ranking of the markedness constraint *ONSET ("no initial consonants") over the faithfulness constraint MAX ("no deletion") as it happened in the previous example.

So, *ONSET outranks the faithfulness constraint MAX. The ranking of constraints is indicated in (82).

**(82) Initial Consonant Deletion**

***ONSET:** Avoid onsets/initial consonants

**MAX:** Input segments must correspond to the output segments. (No deletion.)

Ranking: *ONSET>> MAX

### *ii. Final Consonant Deletion*

Tableau 83 demonstrates how optimality theory accounts for the pattern of final consonant deletion.

**(83)** Final voiced alveolar nasal consonant /n/ is deleted in a word.

| /n̪aɳpan/ 'a male friend.' | *CODA | MAX |
|---|---|---|
| a. [n̪aɳpan] | *! | |
| b.☞[n̪aɳpa] | | * |

Tableau (83) illustrates the conflict between *CODA and MAX. A ranking such as that in tableau 83 prevents final consonants from occurring, as *CODA is ranked higher than MAX. In this case, *CODA outranks the faithfulness constraint MAX. The ranking of constraints is indicated in (84).

**(84) Final Consonant Deletion**

***CODA:** Avoid codas/final consonants of the syllables

**MAX:** Input segments must correspond to the output segments. (No deletion.)

**Ranking: *CODA>> MAX**

***iii. Nucleus Deletion (Vowel and Diphthong)***

**(85)** Deletion of initial back rounded short vowel /u/ in a word **(Initial Vowel Deletion).**

| /uɾal/ 'grinding stone' | *NUCLEUS | MAX |
|---|---|---|
| a. [uɾal] | *! | |
| b.☞ [ɾal] | | * |

**(86)** Deletion of final diphthong /ai/ in a word **(Final Diphthong Deletion).**

| /ɑ:mɑi / 'tortoise' | *NUCLEUS | MAX |
|---|---|---|
| a. [ɑ:mɑi] | *! | |
| b.☞[ɑ:m] | | * |

Tableaus 85 and 86 illustrate the conflict between *NUCLEUS and MAX. A ranking in Figures 85 and 86 prevents the nucleus from occurring, so *NUCLEUS is ranked higher than MAX. In this case, *NUCLEUS outranks the faithfulness constraint MAX. The ranking of constraints is indicated in (87).

**(87) Vowel/Diphthong Deletion**

***NUCLEUS:** Avoid nucleus/diphthongs.

**MAX:** Input segments must correspond to the output segments. (No deletion.)

**Ranking: *NUCLEUS>> MAX**

**b. Syllable Deletion**

Syllable deletions that occur in children's speech, such as /cɑmɑjɑl/ > /mɑjɑl/ is seen as **initial syllable deletion**, /ɑʈuppu/ > /ɑppu/ is seen as **medial syllable deletion,** /ut̪ɑʈu/ > /ut̪ɑ/, /ʋeɳʈɑjɑm/ > /ʋeɳʈɑj/, and /pɑmpɑɾɑm/ > /pɑmpɑ/ is seen as **final syllable deletion** in phonological process analysis.

**Initial syllable deletion**

**(88)** Initial syllable /mu/ is deleted in a word'muʈʈɑi'which is Initial syllable deletion.

| /cɑmɑjɑl/ 'cooking' | *NUCLEUS | *ONSET | MAX |
|---|---|---|---|
| a. [cɑmɑjɑl] | *! | * | |
| b.☞[mɑjɑl] | | | ** |

In the case of initial-syllable deletion, the target word with the syllable structure of the shape CV.CVC.VC, such as /cɑ.mɑj.ɑl/ "cooking" is realized as marked.CVC.VC structure, as in [mɑj.ɑl]. The initial syllable /cɑ/ will not surface if a child's grammar has a high-ranked markedness constraint against CVC.CVV syllables.

**(89)** Medial syllable /ʈu/ is deleted in the word **'**ɑʈuppu' **(Medial syllable deletion)**.

| /ɑʈuppu/ 'stove' | *NUCLEUS | *ONSET | MAX |
|---|---|---|---|
| a. [ɑʈuppu] | *! | * | |
| b. ☞[ɑppu] | | | ** |

In the case of medial-syllable deletion, the target word with the syllable structure of the shape V.CVC.CV, such as /ɑʈuppu/

"Stove," is realized as marked 'VC.CV' structure, as in /ɑppu/. The medial syllable /ʈu/ will not surface if a child's grammar has a high-ranked markedness constraint against V.CVC.CV syllables.

These constraints, *ONSET and *NUCLEUS, prohibit syllables in a word that opens with consonants, as in (90). *NUCLEUS and *ONSET, markedness constraints must be ranked higher than MAX, the faithfulness constraint, which requires that all segments from the input surface the output. The ranking of constraints is indicated in (90).

**(90) Syllable deletion**

***ONSET:** Avoid onsets/initial consonants of the syllables.
***NUCLEUS:** Avoid vowels/diphthongs.
**MAX:** Input segments must correspond to the output segments. (No deletion.)
**Ranking**: *NUCLEUS, *ONSET>> MAX

***iv. Final syllable deletion***

In the case of final-syllable deletion, target words with the syllable structure of the shape, V.CV.CV, such as /u.t̪ɑ.ʈu/ "lip" is realized as marked V.CV structure, as in [ut̪ɑ]; CVC.CVC.VC such as /ʋen̪.t̪ɑ.jɑm/ "fenugreek" is realized as marked CVC.CVC structure, as in [ʋen̪t̪ɑj]; and CVV.CV.CVC, such as /pɑm.pɑ.ɾɑm/ "top," is realized as marked CVC.CV structure, as in /pɑm.pɑ/. The final syllables /ʈu/, /ɑm/, and /ɾɑm/ will not surface if a child's grammar has a high-ranked markedness constraint against V.CV.CV, CVC. CVC.VC, CVC.CV.CVC syllables.

**(91)** Final syllable /ʈu/ is deleted in the word/ut̪ɑʈu/ **(Final syllable deletion)**.

| /u.t̪ɑ.ʈu/ 'lip' | *NUCLEUS | *ONSET | MAX |
|---|---|---|---|
| a. [u.t̪ɑ.ʈu] | *! | * | |
| b. ☞ [u.t̪ɑ] | | | ** |

***NUCLEUS,*ONSET>>MAX**

**(92)** Final syllable /ɑm/ is deleted in the word/ʋen̪t̪ɑjɑm/ **(Final syllable deletion)**.

| /ʋen̪t̪ɑjɑm/ ‘fenugreek’ | *NUCLEUS | *CODA | MAX |
|---|---|---|---|
| a. [ʋen̪.t̪ɑj.ɑm] | *! | * | |
| b.☞ [ʋen̪.t̪ɑj] | | | ** |

***NUCLEUS, *CODA >>MAX**

**(93)** Final syllable /ɾɑm/ is deleted in words /pɑmpɑɾɑm/ **(Final syllable deletion)**.

| /pɑmpɑɾɑm/ ‘paper’ | *NUCLEUS | *ONSET | *CODA | MAX |
|---|---|---|---|---|
| a. [kɑɑ.ki.t̪ɑm] | *! | * | * | |
| b. ☞[kɑɑ.ki] | | | | *** |

***NUCLEUS,*ONSET, *CODA>>MAX**

These constraints, *ONSET and *NUCLEUS; *NUCLEUS and *CODA; *ONSET, *CODA and *NUCLEUS, prohibit syllables in a word-final position, as in (94).

**(94) Syllable deletion**

***ONSET:** Avoid onsets/initial consonants of the syllables.
***NUCLEUS:** Avoid vowels/diphthongs.
***CODA:** Avoid codas/final consonants of the syllables.
**MAX:** Input segments must correspond to the output segments. (No deletion.)
**Ranking**: ***NUCLEUS, *ONSET>> MAX**

## B. Substitution Processes

### a. Backing

In a pattern of backing, labial segment /p/ is replaced by coronal /t̪/ as in /pi:ŋkɑ:n/ > /t̪i:ŋkɑ:n/ (Bilabial backing); coronal segments like / t̪/ and /ʈ/ are replaced by dorsal /k/as in /t̪ɑmpi/ > /kɑmpi/ (Dental backing) and /t̪ɑʈʈu/ > /t̪ɑkku/ (Retroflex backing); coronal segment, alveolar nasal geminated cluster /nn/ is replaced by velar nasal, and dorsal-velar /ŋk/ as in /minnɑl/ > /miŋkɑl/ (both alveolar backing and denasalization); dorsal-palatal /c/ is replaced by dorsal-velar /k/ as in /ʋɑ:cɑm/ >/ʋɑ:kɑm/ (Palatal backing); and front vowel /i/ is replaced by back vowel /u/ as in /i:cɑl/ >/u:cɑl/ (Vowel backing).

An OT account of these error patterns would require proposing the high-ranking markedness constraints, *LABIAL; *CORONAL - RETROFLEX;*CORONAL- DENTAL; *DORSAL - PALATAL; *CORONAL–ALVEOLAR; and *ANTERIOR as in (95). These constraints would be ranked above a faithfulness constraint, IDENT-PLACE, and entails that the input segments straightly resemble the output segments. In this case, IDENT-PLACE ensures that the place of articulation in the input is also preserved in the output.

**(95) Backing process**

***LABIAL:** Avoid labial segments
***CORONAL- RETROFLEX:** Avoid coronal segments
***CORONAL - DENTAL:** Avoid coronal segments
***CORONAL- ALVEOLAR:** Avoid coronal segments
***DORSAL - PALATAL:** Avoid dorsal segments
***ANTERIOR:** Avoid posterior segments.
**IDENT-PLACE:** Preserve place features from input segments.
**Ranking: *LABIAL, *CORONAL-RETROFLEX, *CORONAL-DENTAL,*CORONAL- ALVEOLAR,*DORSAL-PALATAL, *ANTERIOR>> IDENT-PLACE**

Backing happens in both vowel and consonants, and also in the same constraints like DORSAL – PALATAL changes into DORSAL – VELAR as in /ʋɑ:cɑm/ > /ʋɑ:kɑm/. The tableaus 96, 97, 98, 99, 100, and 101 describe the change in place of the segments in these words.

**(96)** Bilabial stop voiceless consonant /p/ is changed as voiceless dental stop /t̪/ in (**Bilabial backing)**

| /pi:ŋkɑ:n/ 'glass' | *LABIAL | IDENT-PLACE |
|---|---|---|
| a. [pi:ŋkɑ:n] | *! | |
| b.☞ [t̪i:ŋkɑ:n] | | * |

*LABIAL>> IDENT-PLACE

**(97)** Voiceless retroflex stop /ʈ/ changed as voiceless velar stop /k/ **(Retroflex backing)**

| /t̪ɑʈʈu/ 'plate' | *CORONAL- RETROFLEX | IDENT-PLACE |
|---|---|---|
| a. [t̪ɑʈʈu] | *! | |
| b. ☞[t̪ɑkku] | | * |

*CORONAL- RETROFLEX>> IDENT-PLACE

**(98)** Voiceless dental stop /t̪/ changed as voiceless velar stop/ʈ/ **(Dental backing)**

| /t̪ampi/ 'whistle' | *CORONAL - DENTAL | IDENT-PLACE |
|---|---|---|
| a. [t̪ampi] | *! | |
| b. ☞[kampi] | | * |

*CORONAL- DENTAL>> IDENT-PLACE

**(99)** Alveolar nasal (*cluster) /nn/ changed as velar nasal and stop/ŋk/ **(Alveolar backing)**

| /minnɑl/ 'lightening' | *CORONAL - ALVEOLAR | IDENT-PLACE | IDENT-MANNER |
|---|---|---|---|
| a. [minnɑl] | **! | | |
| b. ☞[miŋkɑl] | | ** | * |

*CORONAL- DENTAL>> IDENT-PLACE

**(100)** Voiceless palatal stop /c/ changed as voiceless velar stop /k/ (**Palatal backing)**

| /ʋɑ:cam/ | *DORSAL - PALATAL | IDENT-PLACE |
|---|---|---|
| a. [ʋɑ:cam] | *! | |
| b. ☞[ʋɑ:kam] | | * |

*DORSAL - PALATAL>> IDENT-PLACE

**(101)** Front short vowel /i/ changed as back short vowel /u/ (**Vowel backing)**

| /i:cɑl/ | ***ANTERIOR** | **IDENT-PLACE** |
|---|---|---|
| a. [i:cɑl] | *! | |
| b. ☞[u:cɑl] | | * |

*ANTERIOR>> IDENT-PLACE

## b. Fronting

In a pattern of fronting, palatal segment /c/ is replaced by dental /t̪/ as in /cɑ:ʋi/ > /t̪ɑ:ʋi/ (**Palatal fronting**); velar segment /k/ is replaced by dental /t̪/as in/i:kɑi/ > /i:t̪ɑi/ **(Velar fronting)**; retroflex segment /ʈ/ is replaced by dental /t̪/as in/pɑʈʈu/**>**/pɑt̪t̪u/ **(Retroflex fronting)**; Alveolar segment /ɾ/ and /n/ is replaced by dental and labial segments /t̪/ and /m/ as in /oɾuʋɑn/ > /ot̪uʋɑm/ (**Alveolar fronting);** dental segment /t̪/is replaced by bilabial /p/ as in/kɑt̪t̪i/ > /kɑppi/ **(Dental fronting)**; and posterior vowel segment /u:/ is replaced by anterior vowel segment /i:/ as in u:t̪ɑl/ > /i:t̪ɑl / **(Vowel fronting)**.

An OT account of this error pattern would require proposing for the high-ranking markedness constraints, *DORSAL – PALATAL; *DORSAL - VELAR; *CORONAL - RETROFLEX; *CORONAL-ALVEOLAR; *CORONAL- DENTALand *POSTERIOR, as in (102). These constraints would be ranked above a faithfulness constraint, IDENT-PLACE, which entails that the input representation straightly resembles the output representation. In this case, IDENT-PLACE ensures that the place of articulation in the input is also preserved in the output.

**(102) Fronting Process**

***DORSAL – PALATAL:** Avoid dorsal-palatal segments.
***DORSAL – VELAR:** Avoid dorsal-velar segments.
***CORONAL – RETROFLEX:** Avoid Coronal-Retroflex segment.
***CORONAL– ALVEOLAR:** Avoid Coronal-Alveolar segment.
***CORONAL-DENTAL:** Avoid the Coronal-Dental segment.

***Posterior:** Avoid Posterior vowel segments.
**Ident-Place:** Preserve place features in the input segments.
**Ranking:*Dorsal-Palatal, *Dorsal-Velar, *Coronal-Retroflex, *Coronal-Alveolar, *Coronal- Dental, *Posterior >> Ident-Place**

Fronting happens in both vowel and consonants, and also in the same constraints like Coronal – Retroflex changes into Coronal - Dental as in /miʈʈɑ:j/> /mit̪t̪ɑ:j/. The tableaus 103, 104, 105, 106, 107, and 108 give the description of the change in place of the segments in these words.

**(103)** Voiceless palatal stop /c/ changed as voiceless dental stop /t̪/ **(Palatal fronting)**

| /cɑ:ʋi/ 'key' | ***DORSAL–PALATAL** | **IDENT-PLACE** |
|---|---|---|
| a. [cɑ:ʋi] | *! | |
| b. ☞ [t̪ɑ:ʋi] | | * |

*DORSAL – PALATAL >> IDENT-PLACE

**(104)** Voiceless velar stop/k/ changed as voiceless dental stop /t̪ / **(Velar fronting)**

| /i:kɑi/ 'charity' | ***DORSAL–VELAR** | **IDENT-PLACE** |
|---|---|---|
| a. [i:kɑi] | *! | |
| b. ☞ [i:t̪ɑi] | | * |

*DORSAL – VELAR >> IDENT-PLACE

**(105)** Voiceless retroflex stop /ʈ/ changed as voiceless dental stop /t̪ / **(Retroflex fronting)**

| /pɑʈʈu/ 'silk' | **CORONAL– RETROFLEX** | **IDENT-PLACE** |
|---|---|---|
| a. [pɑʈʈu] | *! | |
| b. ☞ [pɑt̪t̪u] | | * |

*CORONAL – RETROFLEX >> IDENT-PLACE

/cɑ:ʋi/ > /t̪ɑ:ʋi/ (**Palatal fronting**);/i:kɑi/ > /i:t̪ɑi/ **(Velar fronting);** /pɑʈʈu/>/pɑt̪t̪u/ **(Retroflex fronting);** /oɾuʋɑn/ > / ot̪uʋɑm/ (**Alveolar fronting);** /kɑt̪t̪i/ > /kɑppi/ and /u:t̪ɑl/ > /i:t̪ɑl / **(Vowel fronting)**.

**(106)** Voiced alveolar tap /ɾ/ and voiced alveolar nasal /n/ changed as voiced dental fricative /ð/ voiced bilabial nasal /m/ (**Alveolar fronting)**

| /oɾuʋɑn/ 'one person' | ***CORONAL–ALVEOLAR** | **IDENT-PLACE** |
|---|---|---|
| a. [oɾuʋɑn] | **! | |
| b.☞ [ot̪uʋɑm] | | ** |

*CORONAL– ALVEOLAR >> IDENT-PLACE

**(107)** Voiced alveolar tap /ɾ/ and voiced alveolar nasal /n/ changed as voiced bilabial nasal /m/ (**Dental fronting)**

| /kɑt̪t̪i/'knife' | ***CORONAL– DENTAL** | **IDENT-PLACE** |
|---|---|---|
| a. [kɑt̪t̪i] | *! | |
| b.☞ [kɑppi] | | * |

*CORONAL– DENTAL>> IDENT-PLACE

**(108)** Back rounded long vowel /u:/ changed as front unrounded long vowel /i:/ **(Vowel fronting)**

| /u:t̪ɑl/'Whistle' | **POSTERIOR** | **IDENT-PLACE** |
|---|---|---|
| a. [u:t̪ɑl] | *! | |
| b. ☞ [i:t̪ɑl] | | * |

*POSTERIOR>> IDENT-PLACE

### c. Gliding

Children exhibit two gliding patterns, evident in their productions of /ilɑi/> /ijɑi/ (**Liquid gliding)** and /i:t̪ɑl/ > /i:jɑl/ (**Stop gliding).** To account for children's gliding pattern, it is assumed that *LIQUIDS ("no liquids") and *STOPS ("no stops") outranks

IDENT- CONSONANTAL ("do not change [consonantal]"), as in (109) below.

**(109) Gliding**

***LIQUIDS:** Avoid liquids

***STOPS:** Avoid stops

**IDENT- CONSONANTAL:** Preserve consonantal features in the input segments.

**Ranking: *LIQUIDS>> IDENT- CONSONANTAL**

***STOPS>> IDENT- CONSONANTAL**

Gliding happens in consonants, like *LIQUIDS and *STOPS changes into glides as in /ilɑi/> /ijɑi/ and /i:t̪ɑl/ > /i:jɑl/. The tableaus (110 and 111) give the description of the change in the manner of the segments in these words.

**(110)** Voiced alveolar lateral /l/ changed as voiced palatal approximant /j/ **(Liquid gliding)**

| /ilɑi/ 'leaf' | ***LIQUIDS** | **IDENT-CONSONANTAL** |
|---|---|---|
| a. [ilɑi] | *! | |
| b. ☞[ijɑi] | | * |

*LIQUIDS>> IDENT – CONSONANTAL

**(111)** Voiceless dental stop /t̪/ changed as voiced palatal approximant /j/ **(Stop gliding)**

| /i:t̪ɑl/ 'charity' | ***STOPS** | **IDENT-CONSONANTAL** |
|---|---|---|
| a. [i:t̪ɑl] | *! | |
| b. ☞ [i:jɑl] | | * |

*STOPS>> IDENT- CONSONANTAL

### d. Liquiding

Children exhibit two liquiding patterns, evident in their productions of /muʈi/ >/muri/ **(Stop liquiding)** and /ʋɑ:jmɑi/ > /ʋɑ:lmɑi/ (**glide liquiding).** To account for children's liquiding pattern, it is assumed that *STOPS ("no stops") and *GLIDES ("no glides") outranks IDENT- MANNER ("don't change [MANNER]"), as in (112) below.

**(112) Liquiding**

***STOPS:** Avoid stops
***GLIDES:** Avoid glides
**IDENT- MANNER:** Preserve the manner features of input segments.
**Ranking:**
***STOPS>> IDENT- MANNER**
***GLIDES>> IDENT- MANNER**

Liquiding happens in segments, like *GLIDES and *STOPS. Here glides and stops changes into liquids as in /muʈi/> /muri/ and /ʋɑ:jmɑi/ > /ʋɑ:lmɑi/. The tableaus 113 and 114 give the description of the change in the manner of the segments in these words.

**(113)** Voiceless retroflex stop /ʈ/ changed as voiced alveolar trill /r/ **(Stop liquiding)**.

| /muʈi/ 'hair' | ***STOPS** | **IDENT-MANNER** |
|---|---|---|
| a. [muʈi] | *! | |
| b. ☞ [muri] | | * |

*STOPS>> IDENT-MANNER

**(114)** Voiced palatal approximant /j/ changed as voiced alveolar lateral approximant /l/ **(Glide liquiding)**.

| /ʋɑ:jmɑi/ 'truth' | ***GLIDES** | **IDENT-MANNER** |
|---|---|---|
| a. [ʋɑ:jmɑi] | *! | |
| b. ☞ [ʋɑ:lmɑi] | | * |

*GLIDES>> IDENT- MANNER

**e. Stopping**

Now consider the following stopping error patterns, where /kuɾuʋi/>/kut̪uʋi/ in **Liquid stopping**;/ʋaɳʈi/ > /paɳʈi/ in **Glide stopping**; and /so:p/ > /t̪o:p/ in **Fricative Stopping**. The constraints relevant here are *LIQUIDS (“no liquids”), *GLIDES (“no glides”), and *FRICATIVES (“no fricatives”) and IDENT-CONTINUANT (“do not change [continuant]”).

For stopping, the markedness constraint against liquids, glides, and fricatives outranks the constraint that requires faithfulness to the [continuant] feature, as shown in (115).

**(115) Stopping**

***LIQUIDS:** Avoid liquids
***GLIDES:** Avoid glides
***FRICATIVES:** Avoid fricatives
**IDENT-CONTINUANT:** Preserve the continuant feature in the input segments
**Ranking:**
***LIQUIDS >> IDENT-CONTINUANT**
***GLIDES >> IDENT-CONTINUANT**
***FRICATIVES>> IDENT-CONTINUANT**

Stopping happens in segments, like *LIQUIDS, *GLIDES and *FRICATIVES changes into stops as in kuɾuʋi/>/kut̪uʋi/;/ʋaɳʈi/ > /paɳʈi/; and /so:p/ > /t̪o:p/. The tableaus 116, 117, and 118 give the description of the change in the manner of the segments in these words.

**(116)** Voiced alveolar tap /ɾ/ changed as voiceless dental stop/t̪/ (**Liquid stopping)**

| /kuɾuʋi/ **‘bird’** | *LIQUIDS | IDENT– CONTINUANT |
|---|---|---|
| a. [kuɾuʋi] | *! | |
| b. ☞ [kut̪uʋi] | | * |

*LIQUIDS >> IDENT-CONTINUANT

**(117)** Voiced labiodental glide /ʋ/ changed as voiceless bilabial stop /p/ (**Glide stopping**)

| /ʋan̪t̪i/ 'vehicle' | ***GLIDES** | **IDENT–CONTINUANT** |
|---|---|---|
| a. [ʋan̪t̪i] | *! | |
| b. ☞ [pan̪t̪i] | | * |

*GLIDES >> IDENT-CONTINUANT

**(118)** Labiodental fricative /f/ changed as dental stop /t̪/ (**Fricative Stopping**)

| /so:p/ 'soap' | ***FRICATIVES** | **IDENT - CONTINUANT** |
|---|---|---|
| a. [so:p] | *! | |
| b. ☞ [t̪o:p] | | * |

*FRICATIVES>> IDENT-CONTINUANT

**a. Height Positioning**

In the examples /aɾacan/> /aɾacen/ in **Vowel raising;** and / imai/ > /amai/ in **Vowel lowering,** /o:ʋijam/ > /auʋijam/ in **Diphthongization,** low vowel /a/ of /aɾacan/ and high vowel /i/ of /imai/ and high-mid back long vowel /o:/ of /o:ʋijam/ have undergone positioning problems reflecting in high vowel/e/ as / aɾacen/ and low vowel /a/as /amai/ and in the word /o:ʋijam/. However, vowel weight is maintained but substituted with a diphthong /au/ as in /auʋijam/, which is also called a vowel break.

For height positioning, the markedness constraint against *LOW and *HIGH DIPHTHONG outranks the constraint that requires faithfulness to the [height] / [Aperture] feature, as shown in (119).

**(119) Height Positioning**

***LOW:** Avoid low vowels
***HIGH:** Avoid High vowels
**DIPHTHONG:** Vowel split/break
**IDENT-HEIGHT:** Preserve the height feature in the input segments

**Ranking:**
***Low >>Ident-Height***
***High >>Ident-Height***

Height positioning errors like lowering and raising or alternation in height by substituting with diphthong happen in vowel segments, like *Low, *High, and Long monophthong changes into high, low vowels and diphthong as in /ɑɾɑcɑn/**>** / ɑɾɑc**e**n/ and /**i**mɑi/ > /ɑmɑi/ and /o:ʋijɑm/ > /ɑuʋijɑm/. The tableaus 120, 121, and 122 describe the change in the height of the segments in these words.

**(120)** Central unrounded low short vowel /ɑ/ changed as front unrounded high-mid vowel /e/ (**Vowel raising**)

| /ɑɾɑcɑn/ 'handsome' | *LOW | IDENT-HEIGHT |
|---|---|---|
| a. [ɑɾɑcɑn] | *! | |
| b. ☞ [ɑɾɑcen] | | * |

***LOW >>IDENT-HEIGHT**

**(121)** Front high vowel /i/ changed as central low vowel /ɑ/ (**Vowel lowering**)

| / ilɑi/ 'leaf' | *HIGH | IDENT-HEIGHT |
|---|---|---|
| a. [ilɑi] | *! | |
| b. ☞[ɑlɑi] | | * |

***HIGH >>IDENT-HEIGHT**

**(122)** Long back rounded vowel /o:/ changed as diphthong /ɑu/ (**Diphthongization**)

| /o:ʋijɑm/ 'painting' | DIPHTHONG | IDENT-HEIGHT |
|---|---|---|
| a. [o:ʋijɑm] | *! | |
| b. ☞ [ɑuʋijɑm] | | * |

**DIPHTHONG >>IDENT-HEIGHT**

**b. Duration Shift**

Children with phonological disorders have more problems in duration sustaining as equal to deletion. It can be seen in examples like; (i) /uppu/ > /u:ppu/ in **Vowel lengthening;** (ii) /ɑ:mɑi/> /ɑmɑi/ in **Vowel shortening;** and (iii) /ɑuʋɑi/ > /ɑʋɑi/ in **Monophthongization**; where short vowel /u/ of /uppu/ and long vowel /ɑ:/ of /ɑ:mɑi/, /o:/ of /o:ʋijɑm/and diphthong /ɑu/ (which has a heavy syllable weight of long vowel and diphthong) of / ɑuʋɑi/ have undergone a duration sustaining problems surfacing with long vowel /u:/ as /u:ppu/ and short vowel /ɑ/ as /ɑmɑi/ and monophthong /ɑ/ as /ɑʋɑi/.

The constraints relevant here are *LAX ("lengthening/change in length") and *TENSE ("shortening, monophthongization/change in length"), under markedness constraint andIDENT-LENGTH ("do not change [length]") under faithfulness constraint.

For duration sustaining, the markedness constraint against *LAX and *TENSE outranks the constraint that requires faithfulness to the [LENGTH] feature, as shown in (123).

**(123) Duration shift**

***LAX:** Avoid short vowels
***TENSE:** Avoid long vowels/diphthongs
**IDENT-LENGTH:** Preserve the duration feature in the input segments.
**Ranking: *LAX >>IDENT-LENGTH**
***TENSE >>IDENT-LENGTH**

Duration shifting problems like shortening, lengthening, and monophthongization happens in vowel segments, like LAX (short vowel), and TENSE (long vowel/diphthong), changes into long, and short or monophthong vowels as in /uppu/ > /u:ppu/**;** /ɑ:mɑi/> /ɑmɑi/**;** and /ɑuʋɑi/ > /ɑʋɑi/. The tableaus 124, 125, and 126 give the description of the change in length of the segments in these words.

**(124)** Back short vowel /u/ changed as back long vowel /u:/ (**Vowel lengthening**)

| /uppu/ ‘salt’ | ***LAX** | **IDENT-LENGTH** |
|---|---|---|
| a. [uppu] | *! | |
| b. ☞ [u:ppu] | | * |

***LAX >>IDENT-LENGTH**

**(125)** Central long vowel /ɑ:/ changed as central short vowel /ɑ/ (**Vowel shortening**)

| /ɑ:mɑi/ ‘tortoise’ | ***TENSE** | **IDENT-LENGTH** |
|---|---|---|
| a. [ɑ:mɑi] | *! | |
| b. ☞ [amɑi] | | * |

***TENSE >>IDENT-LENGTH**

**(126)** Diphthong /ɑu/ changed as central short vowel /ɑ/ (**Monophthongization**)

| /ɑuʋɑi/ ‘name of a Tamil poet’ | ***TENSE** | **IDENT-LENGTH** |
|---|---|---|
| a. [ɑuʋɑi] | *! | |
| b. ☞ [ɑʋɑi] | | * |

***TENSE >>IDENT-LENGTH**

## C. Assimilation Processes

The children with phonological disorders have applied the following assimilation processes. They are Nasalization/ Nasal assimilation as in /ɑmpu/ > /ɑmmu/, Labialization/ Bilabial assimilation (Denasalization) as in /onpɑt̪u/ > /oppɑt̪u/, Velarization/Velar assimilation as in /oʈʈɑkɑm/ > /okkɑkɑm/, Dental assimilation as in /t̪ɑʈʈu/ > /t̪ɑt̪t̪u/, Palatal assimilation as in /ɑɾɑcɑn/ > /ɑcɑcɑn/, Lateral assimilation as in /ɑɳil/ > /ɑlil/, and Glide assimilation as in /ce:mijɑ:/ > /ce:jijɑ:/.

For assimilation, the markedness constraint against AGREE-NASAL, AGREE-LABIAL, AGREE-VELAR, AGREE-DENTAL, AGREE-PALATAL, AGREE-LATERAL, and AGREE-GLIDE outrank the constraint that requires faithfulness to the [manner/place] feature, as shown in (127).

**(127) Assimilation**

**AGREE-NASAL:** Change the segment due to neighboring nasals

**AGREE-LABIAL:** Change the segment due to neighboring labials

**AGREE-VELAR:** Change the segment due to neighboring velars

**AGREE-DENTAL:** Change the segment due to neighboring dentals

**AGREE-PALATAL:** Change the segment due to neighboring palatals

**AGREE-LATERAL:** Change the segment due to neighboring laterals

**AGREE-GLIDE:** Change the segment due to neighboring glides

**IDENT-MANNER:** Preserve the manner feature in the input segments

**IDENT-PLACE:** Preserve the place feature in the input segments

**Ranking:**

**AGREE-NASAL >>IDENT-MANNER**
**AGREE-LABIAL >>IDENT-MANNER, IDENT-PLACE**
**AGREE-VELAR >>IDENT-PLACE**
**AGREE-DENTAL >> IDENT-PLACE**
**AGREE-PALATAL >> IDENT-MANNER**
**AGREE-LATERAL >> IDENT-PLACE, IDENT-MANNER**
**AGREE-GLIDE >> IDENT-PLACE, IDENT-MANNER**

Assimilation happened in segments like, /mp/, /np/, /ʈʈ/, /ʈʈ/, /ɾ/, /ɳ/, /m/, that changes into /mm/, pp/, /kk/, /t̪t̪/, /c/, /l/, /j/ as in /ɑmpu/ > /ɑmmu/, /onpɑt̪u/ **>** /oppɑt̪u/, /oʈʈɑkɑm/ > /okkɑkɑm/, / t̪ɑʈʈu/ > /t̪ɑt̪t̪u/, /ɑɾɑcɑn/ > /ɑcɑcɑn/, /ɑɳil/ > /ɑlil/, and /ce:mijɑ:/ > /ce:jijɑ:/. The tableaus 128, 129, 130, 131, 132, 133, and 134 illustrate the description of the change in the manner or place of the segments in these words.

**(128)** Voiceless bilabial stop /p/ changed as voiced bilabial nasal /m/ (**Nasal assimilation**)

| /ampu/ ‘arrow’ | AGREE-NASAL | IDENT-MANNER |
|---|---|---|
| a. [ampu] | *! | |
| b. ☞ [ammu] | | * |

AGREE-NASAL >>IDENT-MANNER

**(129)** Voiced alveolar nasal /ɳ/ changed as voiceless bilabial stop /p/ (**Bilabial assimilation)**

| /onpat̪u/ > ‘nine’ | AGREE-LABIAL | IDENT-MANNER |
|---|---|---|
| a. [paɳam] | *! | |
| b.☞ [papam] /oppat̪u/ | | * |

AGREE-LABIAL >> **IDENT-MANNER, IDENT-PLACE**

**(130)** Voiceless dental stop /t̪/ changed as voiceless velar stop /k/ (**Velar Assimilation**)

| /oʈʈakam/ ‘door’ | AGREE-DORSAL | IDENT-PLACE |
|---|---|---|
| a. [kat̪aʋu] | *! | |
| b. ☞ [okkakam] | | * |

AGREE- VELAR >> **IDENT-PLACE**

**(131)** Voiceless bilabial stop /p/ changed as voiced bilabial nasal /m/ (**Dental assimilation**)

| / t̪aʈʈu/ ‘plate’ | AGREE-NASAL | IDENT-MANNER |
|---|---|---|
| a. [t̪aʈʈu] | *! | |
| b. ☞ [t̪at̪t̪u] | | * |

AGREE-DENTAL >> **IDENT-PLACE**

**(132)** Voiceless bilabial stop /p/ changed as voiced bilabial nasal /m/ (**Palatal assimilation**)

| /aɾacan/ 'king' | AGREE-PALATAL | IDENT-MANNER |
|---|---|---|
| a. [aɾacan] | *! | |
| b. ☞ [acacan] | | * |

AGREE-PALATAL >> **IDENT-MANNER**

**(133)** Voiceless bilabial stop /p/ changed as voiced bilabial nasal /m/ (**Lateral assimilation**)

| /aɭil/ 'squirrel' | AGREE-LATERAL | IDENT-MANNER |
|---|---|---|
| a. [t̪ampi] | *! | |
| b. ☞ [alil] | | * |

AGREE-LATERAL >> **IDENT-MANNER, IDENT-PLACE**

**(134)** Voiceless bilabial stop /p/ changed as voiced bilabial nasal /m/ (**Glide assimilation**)

| /ce:mija:/ 'Vermicelli' | AGREE-GLIDE | IDENT-MANNER |
|---|---|---|
| a. [ce:mija:] | *! | |
| b. ☞ [ce:jija:] | | * |

AGREE-GLIDE >> **IDENT-MANNER, IDENT-PLACE**

## Metathesis

Metathesis in children with phonological disorders is analyzed using OT as follows:

**(135)** Transposition of the segment /ɾ/ (Onset) of the second syllable /ɾa/ and /c/ (Onset) of the final syllable /can/ of the word /aɾacan/ is a metathesis.

| /aɾacan/ 'king' | *SEQUENCE (coronal…dorsal) | LINEARITY |
|---|---|---|
| a. [a.ɾa.can] | *! | |
| b. ☞ [acaɾan] | | * |

**(136) Consonant harmony and distant segment metathesis**

***SEQUENCE (coronal…dorsal):** Change in the sequence of segments coronal…dorsal.

**LINEARITY:** Preserve the linearity in the sequence of segments

**Ranking**

***SEQUENCE (coronal… dorsal) >> LINEARITY**

The ranking shown in (136) is explained in tableau 135; for the word /ɑɾɑcɑn/ two possible output candidates are the faithful candidate (a) [ɑɾɑcɑn] and the unfaithful candidate (b) [ɑcɑɾɑn]. Thus, to account for the metathesis pattern, *SEQUENCE (coronal…dorsal) is ranked above LINEARITY.

**D. Cluster Simplification**

As seen in TD children's developmental error patterns, children with phonological disorders also exhibit errors like Reduction Epenthesis and Coalescence.

**a. Reduction**

The possible ranking is shown in (137), along with a subsequent tableau that illustrates the pattern of reduction in tableaus 138 and 139).

**(137) Cluster reduction**

***COMPLEX:** Avoid consonant clusters

**MAX:** Input segments must correspond to the output segments. (No deletion.)

**Ranking: *COMPLEX >> MAX**

**(138)** Cluster reduction (Onset): /**s**ku:l/ > /ku:l/

| /treɪn/ 'Train' | *** COMPLEX** | **MAX** |
|---|---|---|
| a. [treɪn] | ***!** | |
| b. ☞[teɪn] | | * |

**(139)** Cluster reduction (**Coda**): /uɳaɾcci/ > /uɳacci/

| /uɳaɾcci/ 'sense' | * COMPLEX | MAX |
|---|---|---|
| a. [uɳaɾcci] | *! | |
| b. ☞[ uɳacci] | | * |

If we evaluate each candidate of the tableaus 138 and 139, it is evident that the faithful candidates (a) undergo a fatal violation of *COMPLEX, as it matches with target [tr-] and [ɾcc] cluster. Thus, to account for the Cluster reduction pattern, *COMPLEX is ranked above MAX.

**b. Epenthesis**

The probable ranking of constraints for epenthesis / ki:ɾt̪t̪i / > / ki:ɾit̪t̪i/ is shown in (140) and explained in the tableau 141.

**(140) Ranking: *COMPLEX >> DEP**

**(141)** Epenthesis: / ki:ɾt̪t̪i / > /ki:ɾit̪t̪i/

| /ki:ɾt̪t̪i/ 'fame' | *COMPLEX | DEP |
|---|---|---|
| a. [ki:ɾt̪t̪i] | *! | |
| b. ☞[ ki:ɾit̪t̪i] | | * |

As happened in cluster reduction, in tableau 141 also, candidate (a) incurs a fatal violation of *COMPLEX as the output sequence has [ɾt̪t̪], and as the insertion of schwa has happened in candidate (b) has [ɾit̪t̪], it violates the lowest ranked constraint DEP. For the epenthesis pattern, the less serious grammar violation is inserting a segment, as in candidate (b). Thus, to account for the epenthesis pattern, *COMPLEX is ranked above DEP.

**c. Coalescence**

For the coalescence pattern in ujaɾʋu/ > /ujat̪u/, UNIFORMITY is ranked lowest than *COMPLEX as in (142).

**(142) Ranking:*COMPLEX >> UNIFORMITY**

**(143)** Coalescence: /ujaɾʋu/ > /ujat̪u/

| /ujaɾʋu/ **'growth'** | ***COMPLEX** | **UNIFORMITY** |
|---|---|---|
| a. [ujaɾʋu] | *! | |
| b. ☞ [ujat̪u] | | * |

From tableau 143, it is inferred that candidate (a) experiences a fatal violation of *COMPLEX as the occurrence of clusters is found, and candidate (b) experiences an optimal violation of UNIFORMITY due to the segmental mismatch between input /ɾʋ/ of [ujaɾʋu] and output /t̪/ of [ujat̪u] forms. Thus, to account for the coalescence pattern, *COMPLEX is ranked above UNIFORMITY.

**E. Denasalization:**

In the denasalization pattern /aɳil/ > /aʋil/, NASAL is ranked lowest than IDENT-NASAL as in (144).

**(144) Ranking:** NASAL >> IDENT-NASAL

**(145) Retroflex nasal /ɳ/ has changed as labio-dental approximant /ʋ/ in a word.**

| /aɳil/ 'Squirril' | ***NASAL** | **IDENT-NASAL** |
|---|---|---|
| a. [aɳil] | *! | |
| b. ☞[aʋil] | | * |

From tableau (145), it is inferred that candidate (a) experiences a fatal violation of *NASAL as the occurrence of the nasal is found, and candidate (b) experiences an optimal violation of IDENT-NASAL due to the segmental mismatch between input /ɳ/ of [aɳil] and output /ʋ/ of [aʋil]. Thus, to account for the denasalization pattern, *NASAL is ranked above NASAL.

**F. Nasalization:**

In the nasalization pattern of /ʋiɾɑl/ > /ʋinɑl/, NASAL is ranked lowest than IDENT-NASAL as in (146).

**(146) Ranking:** *NONASAL >> IDENT-MANNER

**(147) Alveolar tap /ɾ/ has changed as alveolar nasal /n/ in a word.**

| /ʋiɾɑl/ 'finger' | ***NONASAL** | **IDENT-MANNER** |
|---|---|---|
| a. [ʋiɾɑl] | *! | |
| b. ☞[ʋinɑl] | | * |

From tableau (147), it is inferred that candidate (a) experiences a fatal violation of ***NONASAL** as the occurrence of the tap is found, and candidate (b) experiences an optimal violation of **IDENT-MANNER** due to the segmental mismatch between input /ɾ/ of [ʋiɾɑl] and output /n/ of [ʋinɑl]. Thus, to account for the nasalization pattern, ***NONASAL** is ranked above **IDENT-MANNER**.

**G. Reduplication**

Reduplication: **/uɳɑʋu/> /uɳɑɳɑʋu/**

In the reduplication pattern of /uɳɑʋu/> /uɳɑɳɑʋu/, *RED-SYL is ranked lowest than DEP as in (148), where *RED-SYL is the addition (reduplication) of same syllable due to neighbouring syllable

**(148) Ranking: *RED-SYL** >> **DEP**

**(149) Syllable** /ɳɑ/ of /uɳɑʋu/ has been reduplicated as in / uɳɑɳɑʋu/

| /uɳɑʋu/ 'food' | ***RED-SYL** | **DEP** |
|---|---|---|
| a. [uɳɑʋu] | *! | |
| b. ☞[uɳɑɳɑʋu] | | * |

From tableau (149), it is inferred that candidate (a) experiences a fatal violation of ***RED-SYL** as the non-occurrence of reduplicated syllable /ɳɑɳɑ/ is found, and candidate (b) experiences an optimal violation of **DEP**, due to the segmental mismatch between input /ɳɑ/ of [uɳɑʊu] and output /ɳɑɳɑ/ of [uɳɑɳɑʊu]. Thus, to account for the reduplication pattern, ***RED-SYL** is ranked above **DEP**.

**H. Voicing**

In the voicing pattern of /co:ru/ >/ɟo:ru/ and /i:cɑl/ > /i: ɟɑl/, ***DEVOICE** is ranked lowest than **IDENT-VOICE** as in (150) where ***DEVOICE** is avoiding voiceless sound and **IDENT-VOICE** is maintaining the same voice feature.

**(150) Ranking: *DEVOICE >> IDENT-VOICE**

**(151) Voiceless palatal stop /c/ changed as voiced palatal stop /ɟ/ in a word.**

| /co:ru/ ‘cooked rice’ | *DEVOICE | IDENT-VOICE |
|---|---|---|
| a. [co:ru] | *! | |
| b. ☞[ɟo:ru] | | * |

**(152) Voiceless palatal stop /c/ changed as voiced palatal stop /ɟ/ in a word.**

| /i:cɑl/ ‘fly’ | *NOVOICE | IDENT-VOICE |
|---|---|---|
| a. [i:cɑl] | *! | |
| b. ☞[i: ɟɑl] | | * |

***DEVOICE >> IDENT-VOICE**

From tableaus (151 & 152), it is inferred that candidates (a) experience a fatal violation of ***DEVOICE** as the occurrence of the nasal is found, and candidates (b) experience optimal violation of **IDENT-VOICE** due to the segmental mismatch between input /c/ of [co:ru] and [i:cɑl] and output /ɟ/ of [ɟo:ru] and [i: ɟɑl] forms. Thus, to account for the voicing pattern, ***DEVOICE** is ranked above **IDENT-VOICE**.

## I. Affrication

In the affrication pattern of /u:ci/ > /u:ʧi/, *SIMPLE is ranked lowest than UNIFORMITY as in (153) where *SIMPLE avoids single consonant, and IDENT-SIMPLE is to have the same simple/single consonant

**(153) Ranking: *SIMPLE >> UNIFORMITY**

**(154) Voiceless alveolar stop /c/ changed as palatal affricate /ʧ/ sound in a word**

| /u:ci/ 'needle' | *SIMPLE | UNIFORMITY |
|---|---|---|
| a. [u:ci] | *! | |
| b. ☞[u:ʧi] | | * |

From tableau (154), it is inferred that candidate (a) experiences a fatal violation of *SIMPLE as the occurrence of single consonant /c/ is found, and candidate (b) experiences an optimal violation of UNIFORMITY due to the segmental mismatch between input /c/ of [u:ci] and output /ʧ/ of [u:ʧi] forms. Thus, to account for the affrication pattern, *SIMPLE is ranked above UNIFORMITY.

## J. Liquid replacement

In the nasalization pattern of /ɑɾɑn/ >/ɑlɑn/, *TAP is ranked lowest than IDENT-MANNER as in (155) where *TAP is avoiding tap sounds.

**(155) Ranking:** *TAP >> IDENT-MANNER

**(156) Voiced alveolar flap /ɾ/ changed as voiced alveolar lateral approximant /l/ in a word.**

| / ɑɾɑn / 'A fortifying wall' | *TAP | IDENT-MANNER |
|---|---|---|
| a. [ɑɾɑn] | *! | |
| b. ☞[ɑlɑn] | | * |

*TAP >> IDENT-MANNER

From tableau (156), it is inferred that candidate (a) experiences a fatal violation of *TAP as the occurrence of the tap is found, and candidate (b) experiences an optimal violation of IDENT-MANNER due to the segmental mismatch between input /-/ of [-] and output /-/ of [-] forms. Thus, to account for the liquid replacement pattern, *TAP is ranked above IDENT-MANNER.

### H. Multi-Variation (multiple processes in a single word)

As in the previous chapter on the study of phonological acquisition, children with disorders also show multiple errors in a single word uttered. But the error patterns are much more deviant in children with Autism. For example /pampaɾam/ > /m.ɑm/

The phoneme deviance differs from child to child and disorder to disorder. They are explained below using OT.

**1. /pampaɾam/ > /paʋaʋam/**

The phonological processes that happened in the utterance of the child are

**Coalescence:** Bilabial nasal and stop /mp/ in /pampaɾam/ > labio-dental approximant (glide) /ʋ/ and

**Liquid gliding**: Alveolar tap /ɾ/ in /pampaɾam/ > labio-dental approximant /ʋ/

**(157)** Constraints ranking tableau for the word /pampaɾam/

| /pampaɾam/ 'top' | *COMPLEX | *LIQUID | UNIFORM-ITY | IDENT-CONSONANT |
|---|---|---|---|---|
| a. [pampaɾam] | *! | * | | |
| b. ☞[paʋaʋam] | | | * | * |

**(158)** Ranking: ***COMPLEX, *LIQUID >> UNIFORMITY, IDENT-CONSONANT**

From tableau 157, it is inferred that the candidate (a) experiences a fatal violation of *COMPLEX, *LIQUID as the occurrence of cluster /mp/, and liquid /ɾ/ is found in [pampaɾam] and candidate (b) experience optimal violation of UNIFORMITY, IDENT-

CONSONANT, due to the segmental mismatch between input /mp/ and /ɾ/ of [pɑmpɑɾɑm] and corresponding output /ʋ/ and /ʋ/ of [pɑʋɑʋɑm] form. Thus, to account for this multi-phoneme deviant pattern, *COMPLEX, *LIQUID are ranked above UNIFORMITY, IDENT-CONSONANT as in (158).

**2. /kuŋkumɑm/ > /kumpɑpɑm/**

The phonological processes that happened in the utterance of the child are

**Velar nasal fronting:**

Velar nasal fronting: Velar nasal /ŋ/ in /kuŋkumɑm/ > Bilabial nasal /m/

Velar Stop fronting: Velar stop /k/ in /kuŋkumɑm/ > Bilabial stop /p/

**De-nasalization:** Bilabial nasal /m/ in /kuŋkumɑm/ > Bilabial stop /p/

**(159)** Constraints ranking tableau for the word /kuŋkumɑm/

| /kuŋkumɑm/ ‘vermilion’ | ***DORSAL-VELAR** | ***NASAL** | **IDENT-PLACE** | **IDENT-MANNER** |
|---|---|---|---|---|
| a. [kuŋkumɑm] | **!* | * | | |
| b. ☞[kumpɑpɑm] | | | ** | * |

**(160) Ranking: *DORSAL-VELAR,*NASAL >>IDENT-PLACE, IDENT-MANNER**

From tableau (159), it is inferred that the candidate (a) experiences a fatal violation of *DORSAL-VELAR (twice), *NASAL as the occurrence of velar clusters /ŋk/, and nasal /m/ is found in [kuŋkumɑm] and candidate (b) experience optimal violation of IDENT-PLACE, IDENT-MANNER, due to the segmental mismatch between input /ŋk/ and /m/ of [kuŋkumɑm] and corresponding output /mp/ and /p/ of [kumpɑpɑm] form. Thus, to account for this multi-phoneme deviant pattern, *DORSAL-VELAR,*NASAL is ranked above IDENT-PLACE, IDENT-MANNER as in (160).

**3. /ʋeṉṯɑjɑm/ > /ʋe:ʋɑʋɑm/**

The phonological processes that happened in the utterance of the child are

**Vowel lengthening:** mid-high front short vowel /e/ in /ʋeṉṯɑjɑm/ > mid-high front long vowel /e:/

**Coalescence:** dental nasal and stop /ṉṯ/ in /ʋeṉṯɑjɑm/ > labio-dental glide /ʋ/

**Palatal fronting:** palatal glide /j/ in /ʋeṉṯɑjɑm/ > labio-dental glide /ʋ/

**(161)** Constraints ranking tableau for the word /ʋeṉṯɑjɑm/

| /ʋeṉṯɑjɑm/ 'fenugreek' | *LAX | *COM-PLEX | *DORSAL-PALATAL | UNIFORM-ITY | IDENT-LENGTH | IDENT-PLACE |
|---|---|---|---|---|---|---|
| a. [ʋeṉṯɑjɑm] | *! | * | * | | | |
| b.☞ [ʋe:ʋɑʋɑm] | | | | * | * | * |

**(162) Ranking: *LAX, *COMPLEX, *DORSAL –PALATAL >> UNIFORMITY, IDENT-LENGTH, IDENT-PLACE**

From tableau (161), it is inferred that candidate (a) experiences a fatal violation of *LAX, *COMPLEX, *DORSAL –PALATAL as the occurrence of short vowel /e/, clusters /ṉṯ/, and labio-dental glide /ʋ/ is found in [ʋeṉṯɑjɑm] and candidate (b) experiences an optimal violation of IDENT-PLACE, IDENT-MANNER, due to the segmental mismatch between input /ŋk/ and /m/ of [ʋeṉṯɑjɑm] and corresponding output /e:/, /ʋ/ and /ʋ/ of [ʋe:ʋɑʋɑm] form. Thus, to account for this multi-phoneme deviant pattern, *LAX, *COMPLEX, *DORSAL –PALATAL is ranked above UNIFORMITY, IDENT-PLACE, IDENT-MANNER as in (162).

**4. /cɑkkaɾɑm/ > /accɑjɑm/**

The phonological processes that happened in the utterance of the child are:

**Initial consonant deletion:** Palatal Stop /c/ in /cɑkkaɾɑm/ is deleted

**Velar fronting:** Velar stops /kk/ in /cɑkkaɾɑm/ > palatal stops /cc/

**Liquid gliding:** alveolar tap /ɾ/ in /cakkaɾam/ > palatal glide /j/

**(163)** Constraints ranking tableau for the word /cakkaɾam/

| /cakkaɾam/ ‘wheel’ | *ONSET | *DORSAL-VELAR | *LIQUID | MAX | IDENT-PLACE | IDENT-CONSONANT |
|---|---|---|---|---|---|---|
| a. [cakkaɾam] | * | *! | * | | | |
| b. ☞ [accajam] | | | | * | * | * |

**(164) Ranking: *ONSET,*DORSAL-VELAR, *LIQUID >> MAX, IDENT-PLACE, IDENT-CONSONANT**

From tableau (163), it is inferred that the candidate (a) experiences a fatal violation of ***ONSET, *DORSAL-VELAR, *LIQUID** as the occurrence of initial consonant /c/, velar clusters /kk/, and alveolar tap /ɾ/ is found in [cakkaɾam] and candidate (b) experiences an optimal violation of **MAX, IDENT-PLACE, IDENT-CONSONANT** due to the segmental mismatch between input /ŋk/ and /m/ of [cakkaɾam] and corresponding output /deletion of onset/, /cc/ and /j/ of [accajam] form. Thus, to account for this multi-phoneme deviant pattern, ***ONSET,*DORSAL-VELAR, *LIQUID** is ranked above **MAX, IDENT-PLACE,** and **IDENT-CONSONANT** as in (164).

**5. /aɾacan/ > /accat̪an/**

The phonological processes that happened in the utterance of the child are

**Liquid stopping and doubling:** Alveolar tap /ɾ/ / in /aɾacan/ > Palatal Stops /cc/

**Palatal fronting:** Palatal Stop /c/ in /aɾacan/ > dental stop /t̪/

**(165)** Constraints ranking tableau for the word /aɾacan/

| /aɾacan/ ‘king’ | SINGLE-CONS | *DORSAL-PALATAL | UNIFORMITY | IDENT-PLACE |
|---|---|---|---|---|
| a. [aɾacan] | *! | * | | |
| b. ☞[accat̪an] | | | * | ** |

**(166) Ranking: SINGLE –CONS, *DORSAL-PALATAL >> UNIFORMITY, IDENT-PLACE**

From tableau (172), it is inferred that the candidate (a) experiences a fatal violation of SINGLE –CONS, *DORSAL-PALATAL as the occurrence of Alveolar tap /ɾ/, and Palatal Stop /c/ is found in [ɑɾɑcɑn] and candidate (b) experiences an optimal violation of UNIFORMITY, IDENT-PLACE due to the segmental mismatch between input /ɾ/ and /c/ of [ɑɾɑcɑn] and corresponding output /cc/ and /t̪/ of [ɑccɑt̪ɑn] form. Thus, to account for this multi-phoneme deviant pattern, *SINGLE–CONS, *DORSAL-PALATAL is ranked above UNIFORMITY, IDENT-PLACE as in (166).

**6. /pɑjirrunɑɾ/ > /pɑ:ʈʈɑnɑɾ/**

The phonological processes that happened in the utterance of the child are:

**Vowel lengthening:** Low central short vowel /ɑ/ in /pɑjirrunɑɾ/ > Low central long vowel /ɑ:/

**Medial syllable deletion:** Medial (second) syllable /ji/ in /pɑjirrunɑɾ/is deleted

**Liquid stopping:** Alveolar Trill /rr/ in /pɑjirrunɑɾ/ > Retroflex Stop /ʈʈ/

**Vowel lowering:** High back vowel /u/ in /pɑjirrunɑɾ/ > low central vowel /ɑ/

**(167)** Constraints ranking tableau for the word /pɑjirrunɑɾ/

| /pɑjirrunɑɾ/ 'trainer' | *LAX | *ONSET | *NUCLEUS | *LIQUID | *HIGH | IDENT-LENGTH | MAX | IDENT-MANNER | IDENT-HEIGHT |
|---|---|---|---|---|---|---|---|---|---|
| a. [pɑjirrunɑɾ] | *! | * | * | * | * | | | | |
| b.☞[pɑ:ʈʈɑnɑɾ] | | | | | | * | ** | * | * |

**(168) Ranking: *LAX, *ONSET, *NUCLEUS, *LIQUID, *HIGH >> IDENT-LENGTH, MAX, IDENT-MANNER, IDENT-HEIGHT**

From tableau 167, it is inferred that the candidate (a) experiences a fatal violation of *LAX, *ONSET, *NUCLEUS, *LIQUID, *HIGH as the occurrence of Low central short vowel /ɑ/, Medial (second) syllable /ji/, Alveolar Trill /rr/, and High back vowel /u/ is found in [pɑjirrunɑɾ] and candidate (b) experiences an optimal violation of IDENT-LENGTH, MAX, IDENT-MANNER, IDENT-HEIGHT due to the segmental mismatch between input /ɑ/, /ji/, /rr/, and /u/ of [pɑjirrunɑɾ] and corresponding output /ɑː/, /ɸ/, /ʈʈ/, and /ɑ/ of [pɑːʈʈɑnɑɾ] form. Thus, to account for this multi-phoneme deviant pattern, *LAX, *ONSET, *NUCLEUS, *LIQUID, *HIGH is ranked above IDENT-LENGTH, MAX, IDENT-MANNER, IDENT-HEIGHT as in (168).

**7. /t̪iɳʈɑːʈʈɑm/ > /t̪ɑʈʈɑːʈɑm/**

The phonological processes that happened in the utterance of the child are:

**Vowel lowering:** High front short vowel /i/ in /t̪iɳʈɑːʈʈɑm/ > low central short vowel /ɑ/

**Retroflex stop assimilation:** Retroflex stop and nasal cluster /ɳʈ/ in /t̪iɳʈɑːʈʈɑm/ > Retroflex stop /ʈʈ/

**Cluster reduction:** Double retroflex stop /ʈʈ/ in /t̪iɳʈɑːʈʈɑm/ > /ʈ/

**(169)** Constraints ranking tableau for the word /t̪iɳʈɑːʈʈɑm/

| /t̪iɳʈɑːʈʈɑm/ 'troublesome' | ***HIGH** | ***AGREE-RETROSTOP** | ***COMPLEX** | **IDENT-HEIGHT** | **IDENT-MANNER** | **MAX** |
|---|---|---|---|---|---|---|
| a. [t̪iɳʈɑːʈʈɑm] | * | *! | * | | | |
| b. ☞[t̪ɑʈʈɑːʈɑm] | | | | * | * | * |

**(170) Ranking: *HIGH, *AGREE-RETROSTOP, *COMPLEX >> IDENT-HEIGHT, IDENT-MANNER, MAX**

From tableau 169, it is inferred that the candidate (a) experiences a fatal violation of *HIGH, *AGREE-RETROSTOP, *COMPLEX as the occurrence of high front short vowel /i/, Retroflex nasal of /ɳʈ/, Double retroflex stop /ʈʈ/ is found in [t̪iɳʈɑːʈʈɑm] and candidate (b) experience optimal violation of IDENT-HEIGHT, IDENT-MANNER, MAX, due to the segmental mismatch between input /i/, /ɳʈ/, /ʈʈ/ of [t̪iɳʈɑːʈʈɑm] and corresponding output /ɑ/, /ʈʈ/, /ʈ/ of [t̪ɑʈʈɑːʈɑm] form. Thus, to account for this multi-phoneme deviant pattern, *HIGH, *AGREE-RETROSTOP, *COMPLEX is ranked above IDENT-HEIGHT, IDENT-MANNER, MAX as in (170).

**8. /ɑɲcukɑm/ > /ɑccɑpɑm/**

The phonological processes that happened in the utterance of the child are:

**Palatal stop assimilation:** Palatal nasal /ɲc/ in /ɑɲcukɑm/ > Palatal stops /cc/ due to the assimilation of the following stop.

**Vowel lowering:** high back short vowel /u/ in /ɑɲcukɑm/ > low central short vowel /ɑ/

**Velar fronting:** Velar stop /k/ in /ɑɲcukɑm/ > bilabial stop /p/

**(171)** Constraints ranking tableau for the word /ɑɲcukɑm/

| /ɑɲcukɑm/ 'parrot' | *AGREE-PALATALSTOP | *HIGH | *VELAR | IDENT-MANNER | IDENT-HEIGHT | IDENT-PLACE |
|---|---|---|---|---|---|---|
| a. [ɑɲcukɑm] | * | *! | * | | | |
| b. ☞[ɑccɑpɑm] | | | | * | * | * |

**(172) Ranking: *AGREE-PALATALSTOP, *HIGH, *VELAR >> IDENT-MANNER, IDENT-HEIGHT, IDENT-CONSONANT**

From tableau (171), it is inferred that the candidate (a) experiences a fatal violation of AGREE-PALATALSTOP, *HIGH, *VELAR as the occurrence of palatal nasal /ɲc/, high short vowel /u/, velar stop /k/ is found in [ɑɲcukɑm] and candidate (b) experiences an optimal violation of IDENT-MANNER, IDENT-HEIGHT, IDENT-CONSONANT, due to the segmental mismatch between input /ɲc/, /u/, and /k/ of [ɑɲcukɑm] and corresponding output /cc/, /ɑ/, and

/p/ of [ɑccɑpɑm] form. Thus, to account for this multi-phoneme deviant pattern, AGREE-PALATALSTOP, *HIGH, *VELAR is ranked above IDENT-MANNER, IDENT-HEIGHT, IDENT-CONSONANT as in (172).

**9. /ɑccɑm/ > /ɑt̪t̪ɑ:/**

The phonological processes that happened in the utterance of the child are:

Palatal fronting: **Voiceless palatal stops /cc/ > voiceless dental stops /t̪t̪/,**

Vowel lengthening: **low central short vowel /ɑ/ > low central long vowel /ɑ:/**

Final consonant deletion: **deletion of final voiced bilabial nasal /m/**

**(173) Constraints ranking tableau for the word** /ɑccɑm/

| /ɑccɑm/ 'fear' | ***PALATAL** | ***LAX** | ***CODA** | **IDENT-PLACE** | **IDENT-LENGTH** | **MAX** |
|---|---|---|---|---|---|---|
| a. [ɑccɑm] | *! | | | | | |
| b. ☞ [ɑt̪t̪ɑ:] | | | | * | | |

**(174) Ranking: *PALATAL,*LAX, *CODA >> IDENT-PLACE, IDENT-LENGTH, MAX**

From tableau (173), it is inferred that the candidate (a) experiences a fatal violation of *PALATAL,*LAX, *CODA as the occurrence of palatal stops /cc/, low central short vowel /ɑ/ and bilabial nasal /m/ is found and candidate (b) experiences an optimal violation of IDENT-PLACE, IDENT-LENGTH, MAX, due to the segmental mismatch between input /cc/, /ɑ/ and /m/ of [ɑccɑm] and corresponding output /cc/, /ɑ:/ and /m/ of [ɑt̪t̪ɑ:] form. Thus, to account for this multi-phoneme deviant pattern, *PALATAL,*LAX, *CODA is ranked above IDENT-PLACE, IDENT-LENGTH, MAX as in (174).

**10. /ɑːɾɑɲcu/>/ɑnɑn̪t̪u/**

The phonological processes that happened in the utterance of the child are:

Vowel shortening**: Low central long vowel /ɑː/ > low central short vowel /ɑ/**

Nasal assimilation: **voiced alveolar flap /ɾ/ > voiced alveolar nasal /n/**

***Palatal fronting:***

Palatal nasal fronting: **voiceless palatal nasal /ɲ/ > voiceless dental nasal /n̪/ and**

Palatal stop fronting: **Voiceless palatal stop /c/ > voiceless dental stop / t̪/**

**(175) Constraints ranking tableau for the word /ɑːɾɑɲcu/**

| /**ɑːɾɑɲcu**/'Orange | ***TENSE** | ***AGREE-NASAL** | ***DORSAL-PALATAL** | **IDENT-LENGTH** | **IDENT-MANNER** | **IDENT-PLACE** |
|---|---|---|---|---|---|---|
| a. [**ɑːɾɑɲcu**] | *! | * | * | | | |
| b. ☞[**ɑnɑn̪t̪u**] | | | | * | * | * |

**(176) Ranking: *TENSE, *AGREE-NASAL, *DORSAL-PALATAL >> IDENT-LENGTH, IDENT-MANNER, IDENT-PLACE**

From tableau (175), it is inferred that the candidate (a) experiences a fatal violation of *TENSE, *AGREE-NASAL, * DORSAL-PALATAL as the occurrence of low central long vowel /ɑː/, alveolar flap /ɾ/, palatal nasal /ɲ/, and palatal stop /c/ is found in [**ɑːɾɑɲcu**] and candidate (b) experience optimal violation of IDENT-LENGTH, IDENT-MANNER, IDENT-PLACE, due to the segmental mismatch between input /ɑː/, /ɾ/, /ɲ/, and /c/ of [**ɑːɾɑɲcu**] and corresponding output /ɑ/, /n/, /n̪/, and /t̪/ of [**ɑnɑn̪t̪u**] form. Thus, to account for this multi-phoneme deviant pattern, *TENSE, *AGREE-NASAL, * DORSAL-PALATAL is ranked above IDENT-LENGTH, IDENT-MANNER, IDENT-PLACE as in (176).

**Constraints in Tamil phonological disorders**

So after the thorough analysis of the error patterns like deletion, backing, stopping, fronting, gliding, liquiding, height positioning, duration shift, assimilation, metathesis, and cluster simplification of the children with phonological disorders under the OT, the systematic description of both the constraints are listed below:

i. For deletion *CODA, *ONSET, *NUCLEUS outranks MAX,
ii. In backing and fronting, *LABIAL, *CORONAL-RETROFLEX, *CORONAL-DENTAL; *CORONAL-ALVEOLAR, *DORSAL-PALATAL, *DORSAL-VELAR; *POSTERIOR, *ANTERIOR, outranks IDENT-PLACE.
iii. For stopping,*LIQUIDS, *GLIDES, *FRICATIVES, outranks IDENT-CONTINUANT
iv. In gliding, *LIQUIDS, *STOPS outranks IDENT-CONSONANTAL,
v. In liquiding, *STOPS, *GLIDES outranks IDENT-MANNER
vi. For the assimilation, AGREE-LABIALS, AGREE-NASALS, AGREE-DORSALS (PALATAL and VELAR), AGREE-STOPS(PALATAL), AGREE-CORONALS(DENTALS, RETROFLEX- LATERAL), AGREE-GLIDE, outranks IDENT-PLACE, IDENT-MANNER, IDENT-HEIGHT
vii. In the process of metathesis, *SEQUENCE (coronal…dorsal) outranks LINEARITY
viii. In height positioning, *LOW, *HIGH, DIPHTHONG outranks IDENT-HEIGHT
ix. For duration shift, *LAX, *TENSE outranks IDENT-LENGTH
x. For the process of cluster simplification*COMPLEX outranks DEP, UNIFORMITY, MAX,
xi. In Denasalization, *NASAL outranks IDENT-NASAL
xii. In Nasalization, *NONASAL outranks IDENT-MANNER
xiii. In Reduplication, * RED-SYLL outranks IDENT-DEP
xiv. In Voicing, *DEVOICE outranks IDENT-VOICE
xv. For Affrication, *SIMPLE outranks UNIFORMITY
xvi. In Liquid Replacement *TAP outranks IDENT- MANNER

On the whole, the entire error patterns have accounted with 37 markedness constraints and 11 faithfulness constraints.

**Markedness constraints are** *CODA, *ONSET, *NUCLEUS, *LABIAL, *CORONAL-RETROFLEX, *CORONAL-DENTAL; *CORONAL-ALVEOLAR, *DORSAL-PALATAL, *DORSAL-VELAR; *POSTERIOR, *ANTERIOR, *LIQUIDS, *STOPS, *GLIDES, *FRICATIVES, AGREE-LABIALS, AGREE-NASALS, AGREE-DORSALS (PALATAL and VELAR), AGREE-STOPS (RETROFLEX, PALATAL), AGREE-CORONALS (DENTAL, RETROFLEX, LATERAL), AGREE-GLIDE, *NASAL, *NONASAL, *RED-SYLL, *DEVOICE, *SIMPLE, *COMPLEX,*TAP, *LOW, *HIGH, *DIPHTHONG, *LAX, *TENSE, and *SEQUENCE (coronal…dorsal)

**Faithful constraints are** MAX, IDENT-PLACE, IDENT-MANNER, IDENT-CONSONANTAL, IDENT-CONTINUANT, DEP, UNIFORMITY, LINEARITY, IDENT-VOICE, IDENT-LENGTH, and IDENT-HEIGHT.

**Post-Script:**

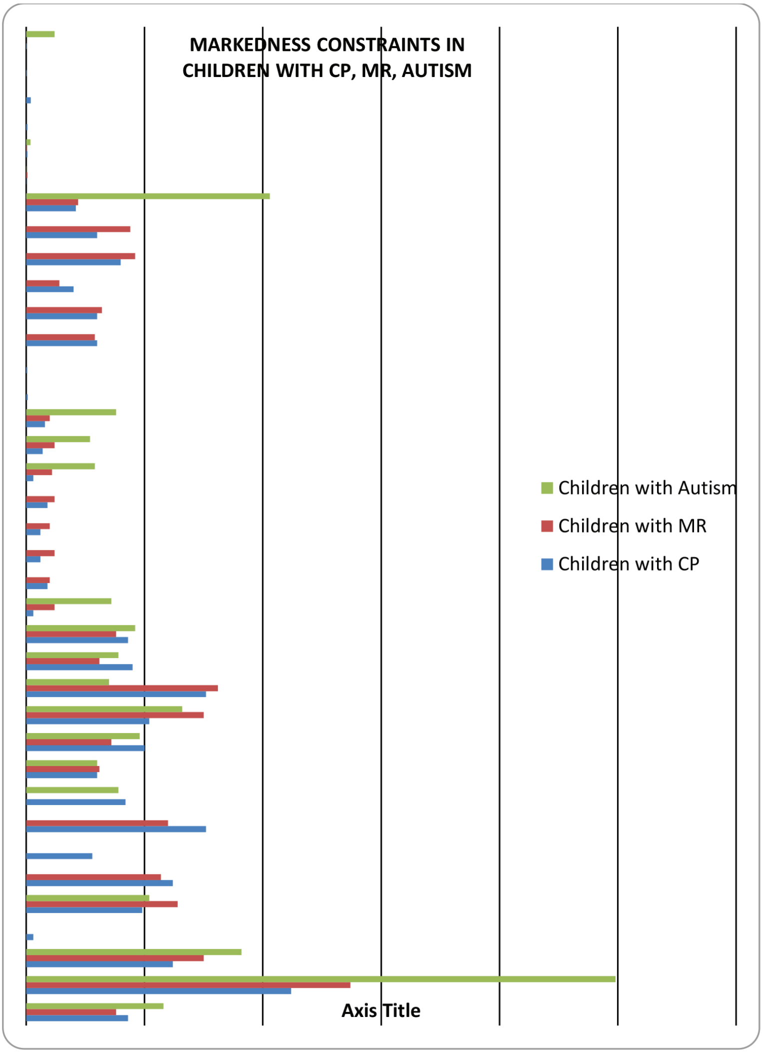
The presence of the marked constraints shows the problems in the children. The study on phonological development in the previous chapter shows that the marked constraints decrease due to the advancement of their age, and in effect, their speech intelligibility increases. Table 18 shows the percentage of marked constraints (MCs) in children in four groups of Children (TD Children, Children with CP, Children with MR, and Children with Auism).

| S.No. | Markedness Constraints | TD Children | Children with CP | Children with MR | Children with Autism |
|---|---|---|---|---|---|
| 1. | *CODA | 3;5 | 4.3 | 3.8 | 5.8 |
| 2. | *ONSET | 3;11 | 11.2 | 13.7 | 24.9 |
| 3. | *NUCLEUS | 3;5 | 6.2 | 7.5 | 9.1 |
| 4. | *LABIAL | 4;11 | 0.3 | 0 | 0 |
| 5. | *CORONAL-RETROFLEX | 4;11 | 4.9 | 6.4 | 5.2 |
| 6. | *CORONAL-DENTAL | 4;11 | 6.2 | 5.7 | 0 |
| 7. | *CORONAL-ALVEOLAR | 4;11 | 2.8 | 0 | 0 |
| 8. | *DORSAL-PALATAL | 4;11 | 7.6 | 6 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 9. | *DORSAL-VELAR | 4;11 | 4.2 | 0 | 3.9 |
| 10. | *POSTERIOR | 4;11 | 3 | 3.1 | 3 |
| 11. | *ANTERIOR | 4;11 | 5 | 3.6 | 4.8 |
| 12. | *LIQUIDS | 4;11 | 5.2 | 7.5 | 6.6 |
| 13. | *STOPS | 4 | 7.6 | 8.1 | 3.5 |
| 14. | *GLIDES | 4;11 | 4.5 | 3.1 | 3.9 |
| 15. | *FRICATIVES | 4;5 | 4.3 | 3.8 | 4.6 |
| 16. | AGREE-LABIAL | 3;11 | 0.3 | 1.2 | 3.6 |
| 17. | AGREE-NASAL | 4;11 | 0.9 | 1 | 0 |
| 18. | AGREE-PALATAL | 3;11 | 0.6 | 1.2 | 0 |
| 19. | AGREE- VELAR | 3;11 | 0.6 | 1 | 0 |
| 20. | AGREE-STOP | 4 | 0.9 | 1.2 | 0 |
| 21. | AGREE-DENTAL | 3;11 | 0.3 | 1.1 | 2.9 |
| 22. | AGREE- LATERAL | 3;11 | 0.7 | 1.2 | 2.7 |
| 23. | AGREE- RETROFLEX | 3;11 | 0.8 | 1 | 3.8 |
| 24. | AGREE- GLIDE | - | 0.07 | 0 | 0 |
| 25. | *SEQUENCE | 3;5 | 0.05 | 0 | 0 |
| 26. | *LOW | 2;11 | 3 | 2.9 | 0 |
| 27. | *HIGH | 3;5 | 3 | 3.2 | 0 |
| 28. | DIPHTHONG | - | 2 | 1.4 | 0 |
| 29. | *LAX | 4 | 4 | 4.6 | 0 |
| 30. | *TENSE | 3;5 | 3 | 4.4 | 0 |
| 31. | *COMPLEX | 5 | 2.1 | 2.2 | 10.3 |
| 32. | *NASAL | - | 0.01 | 0.06 | 0.01 |
| 33. | *NONASAL | - | 0.06 | 0.04 | 0.19 |
| 34. | *RED-SYL | - | 0.06 | 0 | 0 |
| 35. | *DEVOICE | - | 0.2 | 0 | 0 |
| 36. | *SIMPLE | - | 0.02 | 0 | 0 |
| 37. | *TAP | - | 0.03 | 0 | 1.2 |

The following graph 2 shows the variation in the presence of markedness constraint among Children with CP, MR, and Autism

Graph 2


MARKEDNESS CONSTRAINTS IN CHILDREN WITH CP, MR, AUTISM
Children with Autism
Children with MR
Children with CP
Axis Title

CHAPTER – 5

# Remediation of Phonological Disorder

Children with speech-sound disorders need their phonological problems to be remediated for better communication. The phonological disorder must be remediated to make the speech more understandable. The remedial measures will reduce the phonological processes in their speech. The higher the phonological processes in their speech, the more intensely it will affect their language/speech clarity. There are a lot more phonological intervention methods for remediating phonological disorders. The phonological intervention methods consist of the procedures and application of phonemes. All these intervention methods are intended to include absent sounds and renovate the child's phonological system, reducing the phonological processes. The erred phonemes are targeted to resolve by using appropriate phonological intervention methods. Intervention methods need a proper word list for implication. In English, many remedial manuals and word lists have been framed for remediating phonological disorders in many Western countries. The word list was collected for all the consonants, vowels, clusters, and rhyming words. Using that, the therapist will make appropriate choices according to the child's erred pattern. For example, the word list model mentioned above was given on the website of Caroline Brown's (1998) "speech-language therapy.com". This website elaborately discusses the intervention methods with the word list for remediating phonological disorders. Likewise, many remedial manuals and resources were available for the English language. However, for South Indian languages, not many studies have been conducted, and no remedial resources or manuals were available.

**Research Contribution Related to the Present Study**

The following are the earlier studies on phonological intervention in children with mental retardation. The following reviews also include a few investigations on structuring the remedial manual for intervention.

Ann A. Tyler, Mary Louise Edwards, and John H. Saxman (1987) proposed the clinical application of two phonologically based treatment procedures. Two procedures of phonological process-based treatment were applied in the clinical programme, which is conducted for this research purpose. Aged 3;1, 3;8, 4;1, and 5;1, four children were taken as subjects. Two subjects were assigned to a minimal pair contrasting procedure, and two were assigned to a modified cycle procedure based on the results of a detailed phonological analysis. All children demonstrated marked changes in their phonological systems, as shown by the results of pre-treatment and follow-up generalization probes. Correct production generalized to sounds affected by the treatment process that was not a focus of training. Correct production of untrained sounds lagged trained sounds for all subjects. Results support the hypothesis that articulation remediation is enhanced by treating phonological processes, as well as the notion that the acquisition of phonology is a gradual process. Both treatment procedures used in this study were effective and efficient, as evidenced by eliminating up to three phonological processes within two and a half months for each subject.

J.A. Gierut (1989) examined the Maximal Opposition Approach to phonological treatment. The research aimed to evaluate a phonological treatment programme of maximal rather than minimal feature contrasts by charting the learning course in a child displaying a systematic error pattern involving the non-occurrence of word-initial consonants. Generalization data indicated that the child learned 16 word-initial consonants following treatment of only three maximal opposition contrasts. Over-generalization data indicated that the child restructured his phonological system based on a larger concept of "word initialness." The essential components and differences between various forms of contrast treatment were discussed.

Edie Swift and Peggy Rosin's (1990) research describes an approach for remediating speech intelligibility issues in students with Down syndrome. They suggested remedial procedures to improve speech intelligibility for students with Down syndrome. They propose a series of intervention techniques organized using a developmental framework. This sequence emphasizes procedures that address deficits in processing sequential information and includes some procedures that focus on reduced hearing acuity and limited oral-motor control.

Saben, CB. and Ingham, JC. (1991) studied the effects of minimal pair treatment on the speech-sound production of two children with phonologic disorders. Two children whose speech phonologic processes could describe sound production were administered a linguistically-based treatment program with minimal pair words. A subset of phonemes affected by a target phonological process was taught consecutively. Spontaneous picture-naming probes were administered periodically to measure speech-sound production for all phonemes affected by the targeted phonological process and several control phonological processes. For both subjects, motoric components (i.e., models and phonetic placement cues) had to be added to the minimal pair treatment. Both subjects successfully passed through all treatment steps with the added motoric components. However, the subjects neither generalized the modified speech-sound production to treated phonemes in untreated words nor to untreated phonemes affected by the target phonological process.

Judith A. Gierut (1998) analysed the treatment efficacy in children with functional phonological disorders. This research deals with the efficacy of functional phonological disorders in children and has demonstrated such positive effects of the treatment. Children who received phonological treatment exhibited narrow and broad changes in their sound systems. That enhances their overall intelligibility and general communicative functioning. Evidence of the positive outcome of phonological treatment has been reviewed in this study, with particular emphasis on treatment procedures deemed adequate and the specific effects of these treatments in facilitating improved sound production.

D. Almost and P. Rosenbaum (1998) studied the efficacy of speech remediation for phonological disorders using a randomized controlled trial. In this study, 30 children with severe phonological disorders of preschool age were randomly assigned to two treatment groups. Group 1 received treatment for four months, followed by another four months without treatment, while Group 2 underwent four months without treatment, followed by four months of treatment. The outcome measures used were the Assessment of Phonological Processes - Revised (APP-R), the Goldman-Fristoe Test of Articulation (GFTA), the Percentage Consonants Correct (PCC), and Mean Length of Utterance (MLU). Significant differences were noticed in Group 1 after the first four months of the study on scores of phonological processes (APP-R, GFTA, and PCC). At the eight-month assessment point, the measures for conversational speech intelligibility continued to be significantly different, with Group 1 scores higher than those of Group 2. The expressive language measure did not detect a difference between groups at any time; however, Group 1 scores were consistently higher than Group 2 scores.

Barbara Dodd and Amanda Bradford (2000) compared the three remedy methods for children with developmental phonological disorders. Treatment case studies of three children whose speech was characterized by non-developmental errors are described. Three therapy methods were trialed with each child: phonological contrast, core experimented vocabulary, and PROMPT. The implication drawn is that just as no single treatment approach is appropriate for all children with disordered phonology, management of some children may involve selecting and sequencing a range of different approaches.

Amy Glaspey and Carol Stoel-GammGammon (2001) studied a dynamic approach to phonological assessment. Dynamic and static assessments in phonological disorders provide different information about child skills and development. Dynamic assessments evaluate a child's phonological system when given support, whereas static assessments evaluate skills without support. The Scaffolding Scale of Stimulability (SSS), described in this article, is one example of a dynamic assessment used to evaluate phonological disorders. The SSS comprises a 21-point hierarchy of cues and environmental manipulations that can be used to support a child in the production of phonemes. A case study of a four-year-old boy with moderate phonological disorder illustrates the use of the SSS. The SSS is compared to a static assessment, a probe of 60 single words based on the child error patterns. The two assessments are compared across treatment at three different time intervals: before treatment, after three months of treatment, and after six months of treatment. Results indicated that scores on the SSS could differentiate the boy's phoneme productions based on the amount of support needed, while phoneme scores on the probe were at 0 per cent accuracy. As a composite score, the SSS showed a more significant percentage of change earlier in treatment and across time when compared to the probe.

J.A. Barlow (2001) used the constraint-based framework of optimality theory for assessing and remediating children with phonological disorders. This study demonstrates the application of optimality theory in assessing and treating a single child with a phonological disorder. Several prototypical error patterns evident in the child's productions are analysed and are accounted for by assuming that constraints against marked structure are ranked over constraints that require faithfulness to input forms within the child's grammar. A demonstration of how optimality theory accounts for different variations in the child's production is provided. These different types of variation reveal the true nature of certain error patterns, particularly an apparent pattern of cluster reduction. Finally, the analysis results lead to treatment suggestions that focus on the demotion of markedness constraints below faithfulness constraints.

J. Barlow and J. Gierut (2002) inspected minimal pair approaches for phonological remediation. This study considered linguistic approaches that stress the role of the phoneme in language for phonological remediation. The study discussed the structure and function of the phoneme by outlining the procedures for determining contrastive properties of sound systems through the evaluation of minimal word pairs. It also illustrated how these may be applied to a case study of a child with phonological delay. The relative effectiveness of treatment approaches that facilitate phonemic acquisition by contrasting pairs of sounds in minimal pairs is described. A minimal pair treatment efficacy hierarchy emerges based on the number of new sounds, featural differences, and the type of featural differences being introduced. These variables are further applied to the case study, yielding a range of possible treatment recommendations that are predicted to vary in their effectiveness.

Response to Intervention Manual (RIM) was developed by Billie Hightree Sitzmann, Bobbi Hightree, and Leah Moritz, Ed.S., and edited by Sarah Elton (2004). The Individuals with Disabilities Education Act (IDEA) 2004 has authorized local education agencies to use Response to Intervention "RtI" models. RtI is a national movement designed to accomplish three important goals: 1) ensure that all students receive research-based instruction; 2) provide progress monitoring tools that will be utilized in making data-based decisions in terms of interventions and modifications; and 3) provide a more practical method of identifying students as learning disabled (i.e., rather than strictly using a discrepancy model). RtI is an integrated approach that includes general, remedial, and special education. It is based on a three-tiered model that monitors student progress with different levels of intervention intensity. By providing scientifically-based intervention to students, monitoring progress on interventions, and using this information to determine who requires more intensive services, RtI further builds on the requirements of the No Child Left Behind (NCLB) Act. The interventions themselves, in conjunction with comprehensive testing (i.e., intelligence testing, achievement testing, developmental history, etc.), assist in determining a student's verification for special education services.

Law, J., Garrett, Z., and Nye, C. (2004) analyzed the effectiveness of the phonological treatment for children with developmental speech and language delay/disorder. A meta-analysis of interventions for children with primary developmental speech and language delays/disorders was carried out. The results of this study indicated that speech and language therapy might be effective for children with phonological or expressive vocabulary difficulties.

Barbara W. Hodson (2006), in the study "Identifying phonological patterns and projecting remediation cycles," proves the accelerating intelligibility of a seven-year-old Australian child. The prime purpose of this case study was to analyze phonological deviations of a seven-year-old with highly unintelligible speech to (a) identify deficient phonological patterns, (b) determine the severity of his phonological impairment, (c) identify optimal target patterns for treatment, and (d) obtain baseline data to be used for comparison following treatment. The method involved analysing transcriptions of 50 phonological assessment words for occurrences of (a) syllable/word structure omissions, (b) consonant category deficiencies, and (c) substitutions and other strategies. The total occurrences of major phonological deviations placed this client's performance in the profound range of phonological impairment. Primary target patterns for the first cycle of intervention include (a) final consonants, (b) /s/ clusters, (c) velars, and (d) liquids. Potential optimal phoneme targets to enhance the phonological patterns were projected for Cycle One (approximately 16 contact hours).

In their study, D.A. Dinnsen and J.A. Gierut (2008) studied the phonology and clinically induced learning patterns of a female child with a phonological delay (age 4;11) from the analytical perspective of Optimality Theory. The analysis revealed that the child had the error pattern of both Consonant Harmony and Deaffrication. The implications of that analysis for the selection of treatment targets were explored in a treatment study. It was found that treatment aimed at the derived source of Consonant Harmony resulted in the suppression of both Consonant Harmony and Deaffrication. The explanation for these results was attributed to a fixed ranking among certain constraints.

T. Bagetti, M.I. Ceron,, H.B. Mota and M. Keske-Soares, M. (2012) examined phonological changes after applying a therapy approach based on distinctive features in the treatment of phonological disorder. The children were classified according to the severity of the phonological disorder and then underwent treatment based on the Modified Maximal Oppositions Model. Two subjects were grouped for each degree; one was treated by “contrast” and the other by “reinforcement” of the distinctive features in which they showed difficulties. After 20 therapy sessions, the phonological changes before and after the treatment were analysed, considering the type of stimulus presented (“contrast” or “reinforcement”). On the comparative analysis between the groups, it was observed that both groups, treated by “contrast” and by “reinforcement,” demonstrated differences regarding the types of generalizations studied.

M.I. Ceron and M. Keske-Soares (2012) analysed the progress of remediation in children with phonological disorders while applying the Multiple Oppositions Approach. The Multiple Oppositions Approach is described as an alternative model for the treatment of children with severe phonological disorders. The study aimed to evaluate the therapeutic progress of five children with phonological disorders by applying the Multiple Oppositions Approach regarding the phonetic (sounds) and phonological (phonemes and altered distinctive features) inventories. The Multiple Oppositions Approach allows adequate progress in treating subjects with phonological disorders, expanding the phonetic (acquisition of sounds) and phonological (acquisition of phonemes and decreasing the number of altered distinctive features) inventories.

Allen (2013) examines the effect of dose frequency of intervention on phonological performance using the multiple oppositions approach with 54 preschool children and children with speech sound disorder (SSD). Moreover, the results show a more considerable significance by the mean value difference.

Marizete Ilha Ceron, Karina Carlesso Pagliarin, and Márcia

Keske-Soares (2013) analysed Advances in treating children with phonological disorders. This study aims to analyse therapeutic advances (phonetic inventory, phonological system, and distinctive features) in children with phonological disorders by considering the therapeutic approach used, the severity of the phonological disorder, age, and the number of therapeutic sessions. This study showed that the greater the number of therapy sessions, the greater the number of sounds acquired. The number of sounds in the phonetic inventory and phonological system increased, and the severity of the phonological disorder decreased with all the therapeutic approaches studied. There was also a reduction in the incidence of altered distinctive features.

The Efficacy of the Cycles Approach: A Multiple Baseline Design was studied by Johanna M. Rudolpha and Oliver Wendt (2014). The study aimed to assess the efficacy of the Cycles Phonological Remediation Approach as an intervention for children with speech sound disorders (SSD). Phonologically known target patterns showed greater generalization than unknown target patterns across all phases.

**Related Research Contribution from Indian Studies**

Though not many studies have been conducted on manual preparation for South Indian languages, and so far, no manual has been prepared for the remediation of phonological disorders for Tamil-speaking children. Also, no research study has been conducted in this area for the Tamil language. The following two studies were related to this present research related to preparing remedial manuals for Kannada and Malayalam.

Ponnumani (2003) developed a resource manual in Malayalam to remediate children. The study aimed to evaluate the efficacy of the remedial manual and the efficacy of the manual used by school teachers, parents, and speech-language pathologists. The analysis and result of this study proved that the Remedial Manual in Kannada (ReM-Kan) helps enhance the meta-phonological skills of children with reading disabilities. Further, it is also indicated that the Remedial Manual in Kannada (ReM-Kan) is userfriendly; hence, the remedial education service can be partially de-professionalized.

So, the studies mentioned above were carried out abroad, and India indicate that they were using the technique that can address the erred phoneme individually, except the study done by Dinnsen and Gierut (2008).

A study by Lalitha Raja (2015), a major research project funded by ICSSR entitled "Identification and Remediation of Phonological Disorders among Children with Mental Retardation," adopted phonological intervention methods (stated in Section 5.1) and constructed a manual for remediating the phonological disorders with TPKP (Tamil Phonological Knowledge Protocol) and Sentence phonology.

1. TPKP Word list – consists of
    a. 1188 words for all the consonants, and 448 words for all vowels with possible occurrences like initial, medial, and final, along with its CV pattern.
    b. Words for clusters – consists of 293 words for geminated and 128 non-geminated clusters.
    c. Phonograms – consists of around 1736 words in various rhyming word series.

    So, overall, this TPKP consists of 3793 words.
2. Sentence phonology consists of sentences which are from simple to complex sentences. Sentences were framed for all the consonants with their possible series and occurrences. For each consonant, a minimum of five sentences were collected and framed. Moreover, the sentences were consisting of all the series of that consonant.
3. The same module has been undertaken as research by her student Indhumathi (2016) in her research which is a part of the ICSSR Project entitled "Remediation of Phonological Problems in Children with Mental Retardation."

### 5.1. Phonological Intervention Methods

- Minimal Pairs Therapy

  - Minimal Opposition Therapy
  - Maximal Opposition Therapy
  - Multiple Opposition Therapy
- Distinctive Feature Therapy
- Cycles Training
- Metaphone Therapy

## Minimal pairs therapy

In minimal pair therapy, the pairs of rhyming words that differ only by a single phoneme will be focused for therapy. It is used for establishing phonemic contrast. Typically, minimal pairs differ by the fewest distinctive features or the least number of production features, i.e., in the place, manner, and voicing.

### *Minimal opposition therapy*

The minimal opposition approach associates the target sound with its corresponding error substitute. If a child produces [p] as the substitute for other sounds, then the [p] would be introduced with the least contrasted sound during the treatment. The sound [p] combined with the sound [k]. The words are presented in such a manner

படம் /paʈam/ ~ கடம் /kaʈam/ ; பட்டம் /paʈʈam/ ~ கட்டம் / kaʈʈam/

Here, the child's mispronounced sound has been taken as a targeted sound, i.e., usually the substituted sound of the child. The error sound paired with the target sound with minimal distinction in its features. The word lists could be created as follows:

Eg: பட்டம் /paʈʈam/~கட்டம் /kaʈʈam/; பட்டு /paʈʈu/~கட்டு / kaʈʈu/,

Here, the [p] and [k] are distinct in the place of articulation, whereas both are plosive and voiceless.

Generally, the minimal opposition contains the words as follows:

படம் /paʈam/~குடம் /kuʈam/~மடம் /maʈam/~வடம் /ʋaʈam/

***Maximal opposition therapy***

The maximal opposition approach is more similar to minimal opposition. The significant difference between the minimal and maximal opposite approaches deals with comparing sounds that will contrast minimum and maximum with the target sound. The comparison sound should be a known sound/ phoneme of the child. That is, it could be produced by the child correctly. Also, the comparison sound has to be maximally distinct from the target sound. Here is the example given below:

| Comparison sound | Target sound |
|---|---|
| [m] | [t̪] |

The sound [m] could be produced by the child correctly, but not the phoneme [t̪]. These two phonemes differ maximally in their features.

[m] – nasal bilabial voiced [t̪] – stop dental voiceless

Here, the two phonemes differ entirely in their features. So, the wordlist will be as follows for the therapy.

| | | |
|---|---|---|
| மலை~தலை, | மடு~தடு, | மடை~தடை, |
| /malai/~/t̪alai/ | /maʈu/~/t̪aʈu/ | /maʈai/~/t̪aʈai/ |

In this way, their approach helps the child to acquire the target sound.

General examples for maximal opposition;

சுத்தி~புத்தி~தித்தி….

/cut̪t̪i/~/put̪t̪i/~/t̪it̪t̪i/…

கரை~தரை~நரை~வரை..

/kaɾai/~/t̪aɾai/~/n̪aɾai/~/ʋaɾai/….

குட்டை~முட்டை~தட்டை~ராட்டை…

/kuʈʈai/~/muʈʈai/~/t̪aʈʈai/~/ɾa:ʈʈai/….

***Multiple opposition approach***

Under a multiple opposition approach, sound pairs are selected based on the child's substituted sound for the target sounds. That is, the child substitutes the particular sound for all others and will produce /c/ for /t̪ /, /k/,/p/, and /l/, which represent multiple phonemic collapses. Here, the multiple opposition approach includes introducing the error phonemes of /t̪, k, p, l/ along with the substitute sound the child produces, for other phonemes by using minimal pair sets. It could be presented in the following way by pairing the sounds /c/~/t̪ /, /c/~/k/, /c/~/p/, /c/~/v/.

Eg. சட்டம்~தட்டம்; சட்டி~கட்டி; சங்கு~பங்கு;
/caʈʈam/~/t̪aʈʈam/; /caʈʈi/~/kaʈʈi/; /caŋku/~/paŋku/

Here, the goal of multiple oppositions is to include multiple phonemic splits rather than a single phonemic split, as with the minimal pair approach; it also helps to eliminate the homonymy by introducing multiple phonemic splits in the child's system. It targets maximally opposing phonemes within the rule.

**Distinctive feature therapy**

The distinctive feature therapy approach is based on a feature analysis that shows which features are present and absent in the child's phonological system. The features that are presented in the child's phonological pattern will be marked by the symbol [+], and the absent features will be marked by the symbol [-]. For example, if the child has a problem with liquid sounds and is good in the production of nasal sounds, it will be indicated as – liquids and + nasal. So, before moving to therapy, the analysis of the child's phonological pattern is considered. Therapy aims to teach the child to include the absent features in his/her own rule system. Many phoneme pairs that were, in contrast, will be taken for the therapy purpose. i.e., the two phonemes that differ only by the target feature. For example, the choice will be voiced–voiceless, stop–nasal, front–back, and each feature will be given in 3 different levels during therapy. In the first level, the target sound will be given in an isolated manner. In the next level, it will be given in syllable form. In the third level, words with the targeted phonemes using minimal pair words will be focused.

The therapy should be targeted as follows:

***Eg: for voiced – voiceless***

1st level [k] – [g]
2nd level [kɑ] – [gɑ], [ku] – [gu]…

| | | |
|---|---|---|
| 3rd level | பக்கம்~பங்கம் | களவு~குளவு |
| | /pakkam/~/paŋkam/ | /kaɭɑʋu/~/kuɭɑʋu/ |
| | அக்கம்~அங்கம் | கடி~குடி |
| | /ɑkkam/~/ɑŋkam/ | /kaʈi/~/kuʈi/ |

***Eg: for front – back***

1st level [t̪] – [k]
2nd level [t̪ɑ] – [kɑ], [t̪u] - [ku]…

| | | |
|---|---|---|
| 3rd level | தட்டு~கட்டு | தூவு~கூவு |
| | /t̪aʈʈu/~/kaʈʈu/ | /t̪u:ʋu/~/ku:ʋu/ |
| | தம்பி~கம்பி | துணிவு~குணிவு |
| | /t̪ampi/~/kampi/ | /t̪u:ɳiʋu/~/kuɳiʋu/ |

***Eg: for stop – nasal***

1st level [p] - [m]
2nd level [pɑ] – [mɑ], [pɑ:] – [mɑ:]

| | | |
|---|---|---|
| 3rd level | பட்டம்~மட்டம் | பாலை~மாலை |
| | /paʈʈam/~/maʈʈam/ | /pɑ:lɑi/~/mɑ:lɑi/ |
| | படல்~மடல் | பாரி~மாரி |
| | /paʈal/~/maʈal/ | /pɑ:ɾi/~/mɑ:ɾi/ |

As mentioned above, distinctive feature therapy has to be planned according to the child's erred feature pattern.

## Cycle training

Hodson and Paden (1983) introduced the cycle phonological remediation approach. It is a word-based approach. It does not involve using contrastive pairs in the initial level pattern.

*Intervention Procedure for Cycle Approach:*

Cycle

- Phonological acquisition is a gradual process

The target pattern of sounds will be given individually to allow the child to understand the pattern on their own. A phoneme within a pattern is presented/stimulated/targeted for 1 hour (sometimes 2), then another phoneme for that same pattern. A minimum of two phonemes is required per pattern. One cycle consists of 6-18 hours. E.g., Intervention words will be planned as follows for the final consonant deletion /m/and /n/.

பணம், சிங்கம், கோபம், கரம், கம்பம், மரம்
/paɳam/, /ciŋkam/, /ko:pam/, /karam/, /kampam/, /maram/
மன்னன், மான், வீரன், தச்சன், தேன், பொன்
/mannan/, /ma:n/, /ʋi:ran/, /t̪accan/, /t̪e:n/, /pon/

Focused Auditory Input

- Children with normal hearing typically acquire the adult sound system primarily by listening; i.e. the child with normal hearing is able to learn the words by listening to the adults.

The child listens for more than 30 seconds to 15-20 words that an adult speaks. Also, the exact words are recommended to be given in the home once daily. The words could be framed according to the child's phonological pattern. E.g. intervention words will be planned as follows for cluster reduction from the child's erred pattern

சம்பளம், மாம்பழம், சாம்பார், ஆம்பல், பம்பரம்…
/campaɭam/, /ma:mpaɻam/, /ca:mpa:r/, /a:mpal/, /pamparam/….
General examples for consonant cluster
வட்டம், விளக்கு, சிவப்பு, மச்சம், பள்ளி, சுற்றம்…..
/ʋaʈʈam/, /ʋiɭakku/, /ciʋappu/, /maccam/, /paɭɭi/, /curram/…

Facilitative Contexts, Active Involvement, Self-monitoring, and Generalization

- Children associate kinesthetic and auditory sensations as they acquire new patterns; i.e. if the sound is associated with kinesthetic and auditory sensation, the child could better understand the new targeted sounds. Make the child listen to his/her sounds and feel the articulation of sounds by placing the hand in their oral cavities.

A small set of production practice words (target words) is included in each session. In a drill-play format, the child does production practice of individual words. It recommends 7-8 minutes for each session; i.e. the drill is a method that makes the child repeat the target words repeatedly through play methods.

- Children are actively involved in their phonological acquisition; i.e. during the therapy session, the child must participate in every activity to learn the phonological rules.

For that, the play way methods and games are used.

*Ring Round:* the child has to throw the ring in a group of arranged word cards and name the word card where the ring falls.

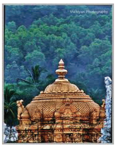
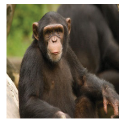
*Buried word:* in this task, the group of word cards will be buried under the sand in a sand tray. The targeted word will be given to the child, and the target word card will be asked to be found from that sand tray.

*Car rally:* The words will be arranged in a sheet to focus on a particular pattern. For example, the initial medial and final [l],[r] words could be arranged in a sheet, and the child has to travel that by saying the word correctly.

For eg: For Medial and final /l/

| சூலம், | நிலம், | பல், | ஊதல், | சல்லடை, | உலகம், |
|---|---|---|---|---|---|
| /cu:lam/ | /ṉilam/ | /pal/ | /u:ṯal/ | /callaṭai/ | /ulakam/ |
| Trident | land | teeth | whistle | strainer | world |
|  |  |  |  |  |  |

For Medial and final /ɾ/

| கோபுரம், | மரம், | சுவர், | குரங்கு, | தேர், | உரம், |
|---|---|---|---|---|---|
| /ko:puɾam/ | /maɾam/ | /cuʋaɾ/ | /kuɾaŋku/ | /t̪e:ɾ/ | /uɾam/ |
|  |  |  |  |  |  |

During therapy sessions, the therapist could manifest several games based on our creativity if we find that helps the child to correct his erred pattern.

- Children tend to generalize new speech production skills to the targets; i.e. in the treatment process, the child could transfer the speech sound features to the other sounds with the same feature. For example, for the final consonant deletion pattern, the remedial procedure targeted the sounds /p/ and /t/, which helps the child to generalize it for other sounds with the same feature.

Optimal Match

- An optimal match facilitates learning in children.

The target pattern has to be one step above the child's current performance level and thus help the child's learning.

The selection of phonological patterns for the cycle approach should follow the developmental sequence.

Advanced level focuses on multisyllabic words with older children who have more difficulty at a conversational level.

One cycle is planned for 6-18 hours in the intervention procedure. Each context will be given approximately 60 minutes later, and only the following pattern will be taken for the cycle. It is recommended that there be only one pattern per session during the period of the first cycle. Cycles range in length from 5 to 16 weeks, depending on the number of patterns targeted.

## Metaphone Therapy

Metaphone therapy focuses on feature differences between sounds in order to develop an awareness that can be classified by characteristics such as duration (long/short), manner (noisy/whisper, stop or flowing), and place (front/back) [Bernthal, Bankson,& Flipsen 2009]. Metaphone therapy is based on metalinguistic awareness. Metalinguistics is the ability to think about and reflect on the nature of language and how it functions. That is developing the child's awareness of phonological structure. Metaphone emphasizes the contrast between speech and sound properties.

Metaphone therapy consists of two phases.

Metaphone therapy

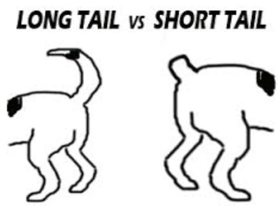
Phase I Phase II

### *Phase I*

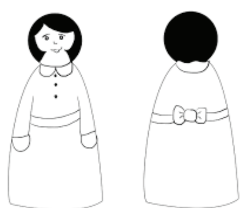
The goal of phase I is to develop phonological awareness in children. Phase I involves four levels of treatment.

1. ***Concept level*** – teaching the concepts of long vs. short, front vs. back, and noisy vs. quiet. The concept teaching will be carried over through the play way method (or) concluding games. For example, by taking a dog toy, we could teach that the nose has to be in front of the dog and the tail has to be in the back of the dog. Through this, the child can create a concept that certain things have to be in front and certain things have to be in the back. Likewise, the concepts of long/short and noisy/quiet will be taught to the child to develop their concepts.

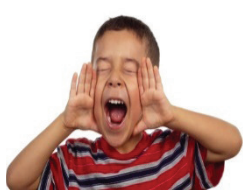
***Long vs. Short***




***Front vs. Back***

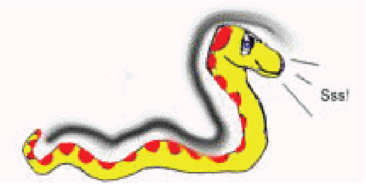


***Noise vs. Quite***



2. ***Sound level*** – in this level, the concept above is applied to the sound system. Here, games like musical instruments or noise-making instruments were used to produce different kinds of sounds. The child must judge the sounds he/ she heard, whether long/short, noisy/quiet, or front/back. E.g. the sound of a snake for quiet sounds and the sound of a lion roaring for noisy sounds.

***Noisy vs. Quiet***




(roaring sound) (hissing sound)

3. ***Phoneme level*** - here, the concept is introduced to the child as an individual phoneme. Therapists will introduce the speech sound or phonemes that vary in dimension (long/short, noisy/quiet, front/back). E.g. /c/ could be identified by the child as a long, quiet, front sound.
4. ***Word level*** – At the word level, the child will be given minimal pair of words and asked to judge it. For example;

பல் /pɑl/ 'teeth' பால் /pɑ:l/ 'milk'

வனம் /ʋanam/ 'forest' வானம் /ʋɑ:nam/ 'sky'

The word has entirely changed by lengthening the sounds /p/ and /v/.

Throughout phase I, the child will remain a listener.

***Phase II:***

It has three goals

- Transfering meta-phonological knowledge to actual communicative environments. Here, the acquired knowledge of phase I activities is transferred to the communicative level
- The child must recognize when the production of the particular utterance and its targets are not matched. If the child confuses the word கண் /kaɳ/ for பெண் /peɳ/, then the therapist has to teach the meaning difference between the word கண் /kaɳ/ for பெண் /peɳ/.
- The child must be able to repair production to achieve successful communication. With the help of the therapist, the child could repair the erred production along with the positive reinforcement of every successful target completion.

One or other of the above methods are widely used all over the planet for the remediation of phonological disorders according to the child's need by speech-language pathologists.

This study intends to address the issue of multi-phoneme deviance using optimality theory. So here, the primary task is to trace the optimal candidates out of the GEN (number of generated candidates) of the underlying representation to reach the surface representation using the chain shift having the sonority principle as a base for chaining the candidates.

## 5.2. Ranking using Chain Shifts

In the study by D.A. Dinnsen and J.A. Barlow (1998), a chain shift, namely the replacement of target /theta/ by [f] and the replacement of /s/ by [theta], was identified in the speech of six children from the two subgroups. Also, in Smith's (1973) reporting of Amahl's speech development and Macken's (1980) subsequent analysis, the following chain shift was identified at 2;2 to 2;11 years of age:

(i) Chain shift in Amahl's phonological development (age 2;2-2;11):
Stopping (all contexts):

a) [pʌdl̩] ‹puzzle’ b) [pɛntl̩] ‘pencil’
Velarization (before liquids):
b) [pʌgl̩] ‘puddle’ d) [bɔkl̩] ‘bottle’
Chain shift: /z/→[d], /d/→[g], /z/↛[g]

According to Karen Jesney (2008), reranking of constraints based on positive target-language evidence is all that is needed, then, in order for developmental chain shifts to both initially emerge and eventually dissipate. They are, thus, restrictive intermediate stages that naturally arise and subside through the regular process of phonological acquisition.

Accordingly, with the above concept, the present study attempted to use the chain shift method to trace the intermediate stages of the child’s utterance for the multi-phoneme deviances to that of the underlying utterances. Considering the multi-phoneme error patterns (i.e., underlying representation (adult utterance): /uɾɑl/ and surface representation (child’s utterance): /iʊɑ/), it has always been a complicated task to explain the ranking of the processes happening in a single word to that of the surface. So, the child moves from its initial state of utterance to the next state by chaining some of the stages of utterances to reach the normative level. Therefore, the initial attempt is to trace the intermediate stages/ other optimal candidates to that of underlying utterance, which will help frame the phonological chains a child can use to develop the phonology.

So the methodology applied here is to explain the series/stages of processes that occurred to the input subsequently, and then to order these stages of processes to match with the surface has been a nonfigurative description. However, the OT grammar can also choose multiple optimal candidates for the target word using the constraints’ violation and can be explained figuratively. The OT applied analysis for the sample data of typically developing children explains the sketch of the process in subsequent stages that tracks from the underlying representation (adult utterance) to surface representation (child’s utterance).

According to the theory, given any input, GEN generates an infinite number of candidates or possible realizations of that input.

Candidates can even be nonwords/meaningless words. Mainly, all the candidates generated for this study are meaningless words. The phonological features of the nonwords were precisely framed to focus the child's attention on the occurrence of velar, liquid, and onset deletions. Meaningless words (rather than actual words) were used in the study for several motives. First, this child was part of a more extensive experimental study in which it was essential to control for individual differences in the words that children might know and for any potential influence of that knowledge on training and learning. Meaningless words offer that control, where all children were unfamiliar with these meaningless words before treatment. Meaningless words have also offered sub-lexical processing advantages (e.g., Vitevitch, Luce, Charles-Luce, & Kemmerer, 1997).

An 'N' number of candidates can be generated for an underlying representation/input. As the study attempts to generate only the candidates (even nonwords) that match the input and child's utterance, the candidates/ nonwords will be with the permutation and combination of the deviant phonemes that match the input and child's utterance. In this sense, the possible candidates that can be generated are $2^n$, where n is the number of the markedness constraints of the child's utterance to that of input. So $N = 2^n$, where 'N' is the number of candidates along with the input and output, and 'n' is the number of markedness constraints. Therefore, in the example input /uɾɑl/ > /iʋɑ/ in the child's utterance, the number of marked constraints is 3, so the number of candidates will be $2^{3,}$ which is 8. Some sample data have been analysed to trace the sub-optimal candidates from input to child's utterance.

**1. /uɾɑl/ > /iʋɑ/** Target word: /uɾɑl/ Child's Utterance: /iʋɑ/

(177) Summary of the ranking of constraints for the word /uɾɑl/ "grinder."

| /uɾɑl/ ‘grinder’ | *LIQUID | *CODA | *POSTERIOR | IDENT-CONSONANTAL | MAX | IDENT-PLACE |
|---|---|---|---|---|---|---|
| a. [uɾɑl] | *! | * | * | | | |
| b. [iɾɑl] | *! | * | | | | * |
| c. [uɾɑ] | *! | | * | | * | |
| d. [iɾɑ] | *! | | | | * | * |
| e. [iʋɑl] | | *! | | * | | * |
| f. ☞ [uʋɑl] (1) | | *! | * | * | | |
| g. ☞ [uʋɑ] (2) | | | *! | * | * | |
| h. ☞ [iʋɑ] | | | | * | * | * |

Multiple optimal candidates are to be chosen by the child’s grammar for the target word /uɾɑl/ to show the processing patterns that happened in a child’s speech to surface [iʋɑ]. Using OT, multiple candidates are selected according to the constraints as in Figure (177). Generally, 10 possible candidates can be generated that match with both input and surface with all probable permutations and combinations. In that case, researchers have a problem explaining the method of multiple changes happening in the stages of a child’s phonotactics to have this surface form. So, the following process has been followed to identify the candidates in the stage of processing. Each subsequent level of candidates has been marked with different colors. The chosen candidate of those intermediate levels has been marked with ☞ and number.

Candidates (a), (b), (c), and (d) are excluded by the child’s grammar due to fatal violations of constraints in the highest-ranked tier. On the other hand, candidates (e), (f), (g), and (h) remain tied as they do not violate the highest ranked constraint (*LIQUID) in this tier. In the next tier, candidates (e) and (f) have fatal violations of constraint (*CODA), whereas (f) has one violation [IDENT-CONSONANTAL] in the faithfulness constraints tier; however, (e) has two violations [IDENT-CONSONANTAL and IDENT-PLACE], so (e) is excluded and (f) is selected out of two equally ranking candidates, as the next optimal candidate in the process which is considered as the immediate change happened from the input of child's grammar. Candidates (g) and (h) remain fixed, as (g) and (h) has no violations in that tier. In the next tier (last tier of markedness), candidate (g) has a fatal violation of the constraint (*POSTERIOR), and (h) has no violation. So (g) is considered the next optimal candidate in the process, which shows the immediate change from candidate (f), and (h) is the highest optimal candidate, which is the surface form of the child's utterance.

Accordingly, candidates (f) [uʋɑl], (g) [uʋɑ], and (h) [iʋɑ] are chosen by the child's grammar according to the proposed ranking in (178). However, again, only one form, candidate (h) [iʋɑ] (indicated in bold ☞), is confirmed in the child's production; nevertheless, the other forms are predicted to occur in the process of multi-variation.

**Description of segmental changes in surface form from underlying form urɑl:**

a. Voiced alveolar flap /ɾ/ changed as voiced labiodental approximant /ʋ/
   Liquid gliding - uɾɑl > uʋɑl - *LIQUID, IDENT-CONSONANTAL
b. Deletion of voiced alveolar lateral approximant /l/
   Final Consonant Deletion - uʋɑl > uʋɑ - *CODA, MAX
c. High back rounded short vowel /u/ changed as high front unrounded short vowel /i/, Vowel fronting - uʋɑ > iʋɑ - *POSTERIOR, IDENT-PLACE

**(178) Ranking: *LIQUID>>*CODA>>*POSTERIOR**

**2. /t̪ɑnni/> /t̪it̪t̪i/**Target word: /t̪ɑnni/ Child's Utterance: /t̪it̪t̪i/

**(179)** Summary of the ranking of constraints for the word /t̪ɑɳɳi/ 'water'.

| /t̪aɳɳi/ 'water' | **AGREE-CORONAL** | **AGREE-HIGH** | **IDENT-MANNER** | **IDENT-HEIGHT** |
|---|---|---|---|---|
| a. [t̪aɳɳi] | *! | * | | |
| b. ☞[t̪at̪t̪i] (1) | | *! | * | |
| c. [t̪iɳɳi] | *! | | | * |
| d. ☞[t̪it̪t̪i] | | | * | * |

Multiple optimal candidates are to be chosen by the child's grammar for the target word /t̪aɳɳi/ to show the processing patterns that happened in a child's speech to surface [t̪it̪t̪i]. Using OT, the multiple candidates are selected according to the constraints as in Figure (179).

The child's grammar excludes candidates (a) and (c) due to fatal violations of constraint (AGREE- CORONAL) in the highest-ranked tier. On the other hand, candidates (b) and (d) remain tied as they do not violate the highest-ranked constraint in this tier. In the next tier, candidate (b) has a fatal violation of constraint (AGREE- HIGH) (b) is selected as the next optimal candidate in the process, which is considered as the immediate change from the input of the child's grammar. Candidate (d) remains fixed, as it has no violations in that tier (last tier of markedness). So (d) is considered the highest optimal candidate, the surface form of the child's utterance.

Accordingly, candidates (b) [t̪it̪t̪i] and (d) [t̪at̪t̪i] are chosen by the child's grammar according to the proposed ranking in (180). Nevertheless, again, only one form, candidate (d) [t̪at̪t̪i] (indicated in bold ☞), is confirmed in the child's production; nevertheless, the other forms are predicted to occur in the process of multi-variation.

**Description of segmental changes in surface form from the underlying form:**

a. Dental /t̪/ assimilates and changes retroflex /ɳɳ/ into /t̪t̪/
Dental Assimilation/ Denasalization - t̪aɳɳi > t̪at̪t̪i –
*AGREE- CORONAL, IDENT- MANNER

b. Low unrounded short vowel /ɑ/ changed as high front unrounded short vowel /i/,
Vowel Raising - t̪at̪t̪i > t̪it̪t̪i - *AGREE- HIGH, IDENT- HEIGHT

**(180) Ranking: *AGREE- CORONAL > *AGREE- HIGH**

**3.** /ɑiʋɑɾ/ **> /ɑlɑ/** Target word: / ɑiʋɑɾ / Child's Utterance: /ɑlɑ /

**(181)** Summary of the ranking of constraints for the word /ɑiʋɑɾ/ 'five members'

| /ɑiʋɑɾ/ 'five members' | *CODA | *GLIDES | *TENSE | MAX | IDENT-MANNER | IDENT-LENGTH |
|---|---|---|---|---|---|---|
| a. [ɑiʋɑɾ] | *! | * | * | | | |
| b. [ɑʋɑɾ] | *! | * | | | | * |
| c. [ɑilɑɾ] | *! | | * | | * | |
| d. [ɑlɑɾ] | *! | | | | * | * |
| e. [ɑʋɑ] | | *! | | * | | * |
| f. ☞ [ɑiʋɑ] (1) | | *! | * | * | | |
| g. ☞ [ɑilɑ] (2) | | | *! | * | * | |
| h. ☞ [ɑlɑ] | | | | * | * | * |

Multiple optimal candidates are to be chosen by the child's grammar for the target word /ɑiʋɑɾ/ to show the processing patterns that happened in a child's speech to surface [ɑlɑ]. Using OT, multiple candidates are selected according to the constraints as in tableau (181).

Candidate (a) is the input form. Candidates (a), (b), (c), and (d) are excluded by the child's grammar due to fatal violations of constraint (*CODA) in the highest ranked tier. On the other hand, Candidates (e), (f), (g), and (h) remain tied as they do not violate the highest-ranked constraint in this tier. In the next tier, candidates (e) and (f) have fatal violations of constraint (*GLIDES), whereas (f) has one violation in the faithfulness constraint [MAX] tier however (e) has two violations [MAX and IDENT-LENGTH], so (e) is excluded and (f) is selected out of two equally ranking candidates, as the next optimal candidate in the process which is considered as the immediate change from the input of child's grammar. Candidates (g) and (h) remain fixed, as (g) and (h) has no violations in that tier. In the next tier (last tier of markedness), candidate (g) has a fatal violation of the constraint (*TENSE), and (h) has no violation. So (g) is considered the next optimal candidate in the process, which shows the immediate change from candidate (f), and (h) is the highest optimal candidate, which is the surface form of the child's utterance.

Accordingly, candidates (f) [ɑiʋɑ], (g) [ɑilɑ], and (h) [ɑlɑ] are chosen by the child's grammar according to the proposed ranking in (182). However, again, only one form, candidate (h) [ɑlɑ] (indicated in bold ☞), is confirmed in the child's production; nevertheless, the other forms are predicted to occur in the process of multi-variation.

**Description of segmental changes in surface form from the underlying form:**

a. Diphthong /ɑi/ substituted with Low central unrounded short vowel /ɑ/

**Final Consonant Deletion -** ɑiʋɑɾ > ɑiʋɑ - *CODA, MAX

b. voiced labio-dental approximant /ʋ/ changed as voiced alveolar lateral approximant /l/

**Glide liquiding -** ɑiʋɑɾ > ɑilɑɾ - *GLIDES, IDENT-MANNER

c. deletion of voiced alveolar flap /ɾ/

**Monophthongization -** ɑilɑɾ > ɑilɑ - *TENSE, IDENT-LENGTH

**(182)** Ranking: *CODA >> *GLIDES >> *TENSE >>

**3. /cɑmɑijɑl/> /t̪ɑmɑjɑ/** Target word: /cɑmɑijɑl/ Child's Utterance: /t̪ɑmɑjɑ/

**(183)** Summary of the ranking of constraints for the word /cɑmɑijɑl/ 'cooking.'

| /camaijal/ ‘cooking’ | *TENSE | *DORSAL | *CODA | IDENT-LENGTH | IDENT-PLACE | MAX |
|---|---|---|---|---|---|---|
| a. [camaijal] | *! | * | * | | | |
| b. [camaija] | *! | * | | | | * |
| c. [t̪amaijal] | *! | | * | | * | |
| d. [t̪amaija] | *! | | | | * | * |
| e. [camaja] | | *! | | * | | * |
| f. ☞ [camajal] (1) | | *! | * | * | | |
| g. ☞ [t̪amajal] (2) | | | *! | * | * | |
| h. ☞ [t̪amaja] | | | | * | * | * |

Multiple optimal candidates are to be chosen by the child’s grammar for the target word /camaijal/ to show the processing patterns that happened in a child’s speech to surface [t̪amaja]. Using OT, the multiple candidates are selected according to the constraints in tableau (183).

Candidates (a), (b), (c), and (d) are excluded by the child’s grammar due to fatal violations of constraints in the highest-ranked tier. On the other hand, candidates (e), (f), (g), and (h) remain tied, as they do not violate the highest ranked constraint (*TENSE) in this tier. In the next tier, candidates (e) and (f) have fatal violations of constraint (*DORSAL), whereas (f) has one violation [IDENT-LENGTH] in the faithfulness constraints tier however, (e) has two violations [IDENT- LENGTH and IDENT-PLACE], so (e) is excluded and (f) is selected out of two equally ranking candidates, as the next optimal candidate in the process which is considered as the immediate change from the input of child’s grammar. Candidates (g) and (h) remain fixed, as (g) and (h) has no violations in that tier. In the next tier (last tier of markedness), candidate (g) has the fatal violation of the constraint (*CODA), and (h) has no violation. So (g) is considered the next optimal candidate in the process, which shows the immediate change from candidate (f), and (h) is the highest optimal candidate, which is the surface form of the child's utterance.

Accordingly, candidates (f) [camajal], (g) [t̪amajal], and (h) [t̪amaja] are chosen by the child's grammar according to the proposed ranking in (184). However, again, only one form, candidate (h) [t̪amaja] (indicated in bold ☞), is confirmed in the child's production; nevertheless, the other forms are predicted to occur in the process of multi-variation.

**Description of segmental changes in surface form from the underlying form:**

a. Diphthong/ai/ changed as Low unrounded short vowel /a/
**Monophthongization -** camaijal > camajal
b. voiceless palatal stop /c/ changed as voiceless dental stop /t̪/
**Palatal fronting -** camajal > t̪amajal
c. deletion of voiced alveolar lateral approximant /l/
**Final Consonant Deletion -** t̪amajal > t̪amaja

**(184) Ranking: *TENSE>>*DORSAL>>*CODA>>**

**4.** /aɲcal/> /accu/ Target word: /aɲcal/ Child's Utterance: /accu/

**(185)** Summary of the ranking of constraints for the word /aɲcal/ 'post'

| /aɲcal/ 'post' | AGREE – STOP | *CODA | *LOW | IDENT-MANNER | MAX | IDENT-HEIGHT |
|---|---|---|---|---|---|---|
| a. [aɲcal] | *! | * | * | | | |
| b. [aɲca] | *! | | * | | * | |
| c. [aɲcul] | *! | * | | | | * |
| d. [aɲcu] | *! | | | | * | * |
| e. [accul] | | *! | | * | | * |

| | | | | | | |
|---|---|---|---|---|---|---|
| f. ☞ [accal] (1) | | *! | * | * | | |
| g. ☞ [acca] (2) | | | *! | * | * | |
| h. ☞ [accu] | | | | * | * | * |

Multiple optimal candidates are to be chosen by the child's grammar for the target word /aɲcal/ to show the processing patterns that happened in a child's speech to surface [accu]. Using OT, the multiple candidates are selected according to the constraints as in tableau (185).

Candidates (a), (b), (c), and (d) are excluded by the child's grammar due to fatal violations of constraints in the highest-ranked tier. On the other hand, Candidates (e), (f), (g), and (h) remain tied, as they do not violate the highest ranked constraint (AGREE -STOP) in this tier. In the next tier, candidates (e) and (f) have fatal violations of constraint (*CODA), whereas (f) has one violation [IDENT-MANNER] in the faithfulness constraints tier however, (e) has two violations [IDENT-MANNER and IDENT-HEIGHT], so (e) is excluded and (f) is selected out of two equally ranking candidates, as the next optimal candidate in the process which is considered as the immediate change from the input of child's grammar. Candidates (g) and (h) remain fixed, as (g) and (h) has no violations in that tier. In the next tier (last tier of markedness), candidate (g) has a fatal violation of the constraint (*LOW), and (h) has no violation. So (g) is considered the next optimal candidate in the process, which shows the immediate change from candidate (f), and (h) is the highest optimal candidate, which is the surface form of the child's utterance.

Accordingly, candidates (f) [accal], (g) [acca], and (h) [accu] are chosen by the child's grammar according to the proposed ranking in (186). However, again, only one form, candidate (h) [accu] (indicated in bold☞), is confirmed in the child's production; nevertheless, the other forms are predicted to occur in the process of multi-variation.

**Description of segmental changes in surface form from the underlying form:**

a. Voiced palatal nasal /ɲ/ changed as voiceless palatal stop /c/
   **Palatal assimilation** - ɑɲcɑl > ɑccɑl - AGREE – STOP, IDENT-MANNER
b. Deletion of voiced alveolar lateral approximant /l/
   **Final Consonant Deletion** - ɑccɑl > ɑccɑ - *CODA, MAX
c. Low central unrounded short vowel /ɑ/ changed as High back rounded short vowel /u/
   **Vowel raising** - ɑccɑ > ɑccu - *LOW , IDENT-HEIGHT

**(186) Ranking: AGREE – STOP >> *CODA >> *LOW >>**

**6. /mɑt̪t̪ɑ:ppu/>** /ɑppɑt̪t̪u/ Target word: /mɑt̪t̪ɑ:ppu/ Child's Utterance: /ɑppɑt̪t̪u/

**(187)** Summary of the ranking of constraints for the word /mɑt̪t̪ɑ:ppu/ 'fire-cracker.'

| /mɑt̪t̪ɑ:ppu/ 'fire-cracker' | *SEQUENCE (coronal…labial) | *ONSET | *TENSE | LINEARITY | MAX | IDENT-LENGTH |
|---|---|---|---|---|---|---|
| a. [mɑt̪t̪ɑ:ppu] | *! | * | * | | | |
| b. [mɑt̪t̪ɑppu] | *! | * | | | | * |
| c. [ɑt̪t̪ɑppu] | *! | | | | * | * |
| d. [ɑt̪t̪ɑ:ppu] | *! | | * | | * | |
| e. ☞ [mɑppɑ:t̪t̪u] (1) | | *! | * | * | | |
| f. [mɑppɑt̪t̪u] | | *! | | * | | * |
| g. ☞ [ɑppɑ:t̪t̪u] (2) | | | *! | * | * | |
| h. ☞ [ɑppɑt̪t̪u] | | | | * | * | * |

Multiple optimal candidates are to be chosen by the child's grammar for the target word /mɑt̪t̪ɑ:ppu/ to show the processing patterns happened in a child's speech to surface [ɑppɑt̪t̪u]. Using OT the multiple candidates are selected according to the constraints as in the tableau (187).

Candidates (a), (b), (c), and (d) are excluded by the child's grammar due to fatal violations of constraints in the highest ranked tier. On the other hand, candidates (e), (f), (g) and (h) remain tied, as they do not violate the highest ranked constraint (*SEQUENCE [coronal…labial]) in this tier. In the next tier, candidates (e) and (f) have fatal violations of constraint (*ONSET); whereas (e) has one violation [LINEARITY] in faithfulness constraints tier however (f) has two violations [LINEARITY and IDENT-LENGTH], so (f) is excluded and (e) is selected out of two equally ranking candidates, as the next optimal candidate in the process which is consider as the immediate change from the input of child's grammar. Candidates (g) and (h) remain fixed, as (g) and (h) has no violations in that tier. In the next tier (last tier of markedness), candidate (g) has fatal violation for the constraint *TENSE and (h) has no violation. So (g) is considered as the next optimal candidate in the process which shows the immediate change from candidate (e) and (h) is the highest optimal candidate which is the surface form of the child's utterance.

Accordingly, candidates (e) [mɑppɑːt̪t̪u], (g) [ɑppɑːt̪t̪u], and (h) [ɑppɑt̪t̪u] are chosen by the child's grammar according to the proposed ranking in (188). Yet again, only one form, candidate (h) [ɑppɑt̪t̪u] (indicated in bold☞), is confirmed in child's production; nevertheless, the other forms are predicted to occur in the process of multi-variation.

**Description of segmental changes in surface form from underlying form:**

a. geminated voiceless dental stop /t̪/ interchanged with geminated voiceless bilabial stop /p/
   **metathesis** - mɑt̪t̪ɑːppu > mɑppɑːt̪t̪u - *SEQUENCE (coronal…labial), LINEARITY
b. deletion of initial voiced bilabial nasal /m/

**Initial Consonant Deletion -** mappaːʈʈu̪ > appaːʈʈu̪ - *ONSET, MAX

c. low central unrounded long vowel /ɑː/ changed as Low central unrounded short vowel /ɑ/

**Vowel shortening -** appɑːʈʈu̪ > appaʈʈu̪ - *TENSE, IDENT-LENGTH

**(188)** Ranking: *SEQUENCE (coronal…labial) >> *ONSET >> *TENSE >>

7. /t̪iɳʈɑːʈʈɑm/ > /t̪aʈʈɑːʈɑm/ **Target word:** /t̪iɳʈɑːʈʈɑm/ **Child's Utterance:** /t̪aʈʈɑːʈɑm/ (189) Constraints ranking tableau for the word /t̪iɳʈɑːʈʈɑm/

| /t̪iɳʈɑːʈʈɑm/ 'troublesome' | *HIGH | *AGREE-RETROSTOP | IDENT-HEIGHT | IDENT-MANNER | |
|---|---|---|---|---|---|
| a. [t̪iɳʈɑːʈʈɑm] | * | *! | | | |
| b. [t̪aɳʈɑːʈʈɑm] | | * | * | | 1 |
| c. ☞[t̪iʈʈɑːʈʈɑm] | * | | | * | 1 |
| d. ☞[t̪aʈʈɑːʈʈɑm] | | | * | * | 2 |

Multiple optimal candidates are to be chosen by the child's grammar for reaching the target word /ɑɾɑcɑn/ and to show the processing patterns that happened in a child's speech from **[t̪aʈʈɑːʈʈɑm]**. Using OT, multiple candidates are selected according to the constraints in Tableux (189).

i. For the selection of the next optimal candidate to the child's utterance **[**t̪aʈʈɑːʈʈɑm**]**, candidates [t̪iʈʈɑːʈʈɑm] and [t̪aɳʈɑːʈʈɑm] are having one faithfulness constraint. However, candidate [t̪iʈʈɑːʈʈɑm] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [t̪aʈʈɑːʈʈɑm].
   So re-ranking is [t̪aʈʈɑːʈʈɑm]> [t̪iʈʈɑːʈʈɑm]
ii. From this reranking, the next candidate is the input or underlying representation [t̪iɳʈɑːʈʈɑm]**.**
   So the final re-ranking is [t̪aʈʈɑːʈʈɑm]> [t̪iʈʈɑːʈʈɑm]> [t̪iɳʈɑːʈʈɑm]

iii. So the **ReRanking** of constraints is**:** ***HIGH >*AGREE-RETROSTOP**

**(190) Ranking: *HIGH >*AGREE-RETROSTOP**

**8.** /cakkaɾam/>/accajam/ **Target word:** /cakkaɾam/ **Child's Utterance:** /accajam/

**(191)** Constraints ranking tableau for the word **/cakkaɾam/**

| /cakkaɾam/ 'wheel' | *ONSET | *DORSAL-VELAR | *LIQUID | MAX | IDENT-PLACE | IDENT-CONSONANT | |
|---|---|---|---|---|---|---|---|
| a. [cakkaɾam] | * | **! | * | | | | **0** |
| b. [cakkajam] | * | **! | | | | * | ~~1~~ |
| c. [caccaɾam] | *! | | * | | ** | | 2 |
| d. [caccajam] | *! | | | | ** | * | ~~3~~ |
| e. ☞[akkaɾam] | | **! | * | * | | | 1 |
| f. ☞[accaɾam] | | | *! | * | ** | | 3 |
| g. [akkajam] | | **! | | * | | * | ~~2~~ |
| h. ☞[accajam] | | | | * | ** | * | 4 |

Multiple optimal candidates are to be chosen by the child's grammar for reaching the target word **/cakkaɾam/** and to show the processing patterns happened in a child's speech from [accajam]. Using OT, multiple candidates are selected according to the constraints in tableau (191).

i. For the selection of the next optimal candidate for the child's utterance [accajam], Candidates d. [caccajam], f. [accaɾam], which are equally having three faithfulness constraints are taken into account. Among the candidates d. [caccajam], f. [accaɾam] for the selection of the next optimal candidate,

candidate [accaɾam] has been selected as the next optimal candidate as it is near sonorous to previous optimal candidate [accajam]

So reranking is [accajam**]** > **[**accaɾam]

ii. For the selection of the next optimal candidate, Candidates c. [caccaɾam], g. [akkajam], which equally having two faithfulness constraints are considered. Among these, [akkajam] is out of selection as the constraint LIQUID has been restrained in earlier selection. So, candidate **[**akkaɾam**]** has been selected as the next optimal candidate.

So the next step in there-ranking is [accajam**]** > **[**accaɾam] > [akkaɾam]

iii. For the selection of the next optimal candidate, Candidates b. [cakkajam],e. [akkaɾam], which equally have one faithfulness constraint, are taken into account. Among these, [cakkajam] is out of selection as the constraint LIQUID has been restrained in earlier selection. So, candidate **[**akkaɾam**]**has been selected as the next optimal candidate.

So the next step in there-ranking is [accajam**]** **>[**accaɾam] > [akkaɾam]

iv. From this reranking, the next candidate is the input or underlying representation [**cakkaram].**

v. So the final re-ranking is [accajam**]> [**accaɾam]>[akkaɾam]> [**cakkaram]**

**(192)** Ranking:*LIQUID>*ONSET>*DORSAL-VELAR

**9.** /aɾacan/ > /accaṯan/ **Target word:** /aɾacan/ **Child's Utterance:** /accaṯan/

(193) Constraints ranking tableau for the word /aɾacan/

| /aɾacan/ 'king' | *SINGLE–CONS | *DORSAL-PALATAL | UNIFORM-ITY | IDENT-PLACE | |
|---|---|---|---|---|---|
| a. [aɾacan] | *! | * | | | |
| b. [acacan] | * | * | | | |
| c. ☞ [acaṯan] | | | | * | 1 |
| b. ☞ [accaṯan] | | | * | * | 2 |

Multiple optimal candidates are to be chosen by the child's grammar for reaching the target word /ɑɾɑcɑn/ and to show the processing patterns happened in a child's speech from **[**ɑccɑʈ̪ɑn**]**. Using OT, multiple candidates are selected according to the constraints in tableu (193).

i. For the selection of the next optimal candidate to the child's utterance **[**ɑccɑʈ̪ɑn**]**, only candidate [ɑccɑcɑn] has one faithfulness constraint which can be taken for the selection of the next optimal candidate to that of previous optimal candidate [ɑccɑʈ̪ɑn].
   So re-ranking is [ɑccɑʈ̪ɑn]> [**accɑ**cɑn]
ii. For the selection of the next optimal candidate, candidate [ɑcɑcɑn] has no faithfulness constraint but has one phoneme variation which can connect the previous optimal candidate **[**ɑccɑcɑn] and the final candidate/underlying representation [ɑɲcukɑm].
   So the next step in the re-ranking is [ɑccɑʈ̪ɑn]> [**accɑ**cɑn]> [**ɑcɑc**ɑn]
iii. From this reranking, the next candidate is the input or underlying representation [ɑɲcukɑm]**.**
   So the final re-ranking is [ɑccɑpɑm]> [**accɑ**kɑm]> [**accu**kɑm]> [ɑɲcukɑm]
iv. So the **ReRanking** of constraints is **: *SINGLE-CONS > *HIGH >*AGREE-PALATALSTOP**
   **(194) Ranking: *SINGLE-CONS > *HIGH >*AGREE-PALATALSTOP**

**10.** /kuŋkumɑm/>/kumpɑpɑm/ **Target word:** /kuŋkumɑm/ **Child's Utterance:** /kumpɑpɑm/

(195) Constraints ranking tableau for the word /kuŋkumɑm/

| /kuŋkumɑm/ 'vermilion' | ***DORSAL-VELAR** | ***NASAL** | ***HIGH** | **IDENT-PLACE** | **IDENT-NASAL** | **IDENT-HEIGHT** | |
|---|---|---|---|---|---|---|---|
| a. **[kuŋkumɑm]** | *! | * | * | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| b.☞[kuŋkamam] | *! | * | | | | * | 1 |
| c. [kuŋkupam] | *! | | * | | * | | 1 |
| d. [kuŋkapam] | *! | | | | * | * | ~~2~~ |
| e. ☞[kumpamam] | | *! | | * | | * | 2 |
| f. [kumpumam] | | *! | * | * | | | 1 |
| g. [kumpupam] | | | *! | * | * | | 2 |
| h. ☞**[kumpapam]** | | | | * | * | * | **3** |

Multiple optimal candidates are to be chosen by the child's grammar for reaching the target word **/kuŋkumam/** and to show the processing patterns happened in a child's speech from **[kumpapam]**. Using OT, multiple candidates are selected according to the constraints as in tableux (195).

i. For selecting the next optimal candidate for the child's utterance **[kumpapam]**, Candidates d. [kuŋkapam], e. [kumpamam], g. [kumpupam], which are equally having two faithfulness constraints, are taken into account. Among the candidates d. [kuŋkapam], e. [kumpamam], g. [kumpupam]; for the selection of the next optimal candidate, candidate [kumpamam] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [kumpapam].
So re-ranking is [kumpapam**]** > **[**kumpamam]

ii. For the selection of the next optimal candidate, Candidates b. [kuŋkamam], c. [kuŋkupam], f. [kumpumam], which equally have one faithfulness constraint, are taken into account. Among these, [kuŋkupam] is out of selection as the constraint *NASAL has been restrained in earlier selection. Among the other two candidates, b. [kuŋkamam], and f. [kumpumam], candidate [kuŋkamam] has been selected as the next optimal candidate as it is near sonorous to previous optimal candidate **[**kumpamam].
So the next step in the reranking is [kumpapam**]** > **[**kumpamam]> **[**kuŋkamam]

iii. From this reranking, the next candidate is the input or underlying representation [kuŋkumɑm]**.**
So the final re-ranking is [kumpɑpɑm**]** > **[**kumpɑmɑm]> **[**kuŋkɑmɑm] > [kuŋkumɑm]

iv. **So the ReRanking of constraints is :**
***NASAL>*DORSAL-VELAR>*HIGH**
**(196) Ranking : *NASAL>*DORSAL-VELAR>*HIGH**

**11.** /ɑccɑm/>/ɑt̪t̪ɑ:/ **Target word:** /ɑccɑm/ **Child's Utterance:** /ɑt̪t̪ɑ:/

(197) Constraints ranking tableau for the word /ɑccɑm/

| /ɑccɑm/ 'fear' | ***PALATAL** | *LAX | *CODA | IDENT-PLACE | IDENT-LENGTH | MAX | |
|---|---|---|---|---|---|---|---|
| a. [ɑccɑm] | *! | * | * | | | | |
| b. ☞[ɑccɑ] | *! | * | | | | * | 1 |
| c. [ɑccɑ:] | *! | | | | * | * | ~~2~~ |
| d. [ɑccɑ:m] | *! | | * | | * | | 1 |
| e. [ɑt̪t̪ɑ:m] | | | *! | * | * | | 2 |
| f. [ɑt̪t̪ɑm] | | *! | * | * | | | 1 |
| g. ☞[ɑt̪t̪ɑ] | | *! | | * | | * | 2 |
| h. ☞[ɑt̪t̪ɑ:] | | | | * | * | * | 3 |

Multiple optimal candidates are to be chosen by the child's grammar for reaching the target word /ɑccɑm/ and to show the processing patterns happened in a child's speech from **[**ɑt̪t̪ɑ:**]**. Using OT, multiple candidates are selected according to the constraints in tableux (197).

i. For the selection of the next optimal candidate to the child's utterance **[**ɑt̪t̪ɑ:**]**, Candidates c. [ɑccɑ:], e. [ɑt̪t̪ɑ:m], g. [ɑt̪t̪ɑ], which are equally having two faithfulness constraints are taken into account. Among the candidates c. [ɑccɑ:], e. [ɑt̪t̪ɑ:m], g.

[ɑt̪t̪ɑ]; for the selection of the next optimal candidate, candidate [ɑt̪t̪ɑ] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [ɑt̪t̪ɑ:]
So re-ranking is [ɑt̪t̪ɑ:] > [ɑt̪t̪ɑ]

ii. For the selection of the next optimal candidate, Candidates b. [ɑccɑ], d. [ɑccɑ:m], f. [ɑt̪t̪ɑm], which equally have one faithfulness constraint, are taken into account. Among these, [ɑccɑ:m] is out of selection as the constraint *LAX has been restrained in earlier selection. Among the other two candidates, b. [ɑccɑ], and f. [ɑt̪t̪ɑm]; candidate [ɑccɑ] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate **[**ɑt̪t̪ɑ].
So the next step in the re-ranking is [ɑt̪t̪ɑ:] > [ɑt̪t̪ɑ] > [ɑccɑ]
From this reranking, the next candidate is the input or underlying representation [ɑccɑm]**.** So the final re-ranking is [ɑt̪t̪ɑ:] > [ɑt̪t̪ɑ] > [ɑccɑ] > [ɑccɑm]

iii. So the **ReRanking** of constraints is **:** *LAX > *PALATAL > *CODA
**(198) Ranking:** *LAX > *PALATAL > *CODA

12. **/ɑ:ɾɑɲcu/>/ɑnɑnt̪u/ Target word: /ɑ:ɾɑɲcu/ Child's Utterance: /ɑnɑnt̪u/**

(199) Constraints ranking tableau for the word /**ɑ:ɾɑɲcu**/

| /**ɑ:ɾɑɲcu**/ 'Orange | *TENSE | *LIQUID | *DORSAL-PALATAL | IDENT-LENGTH | IDENT-MANNER | IDENT-PLACE | |
|---|---|---|---|---|---|---|---|
| a. [**ɑ:ɾɑɲcu**] | *! | * | * | | | | |
| b. [**ɑɾɑɲcu**] | | * | * | * | | | ~~1~~ |
| c. ☞[**ɑ:nɑɲcu**] | * | | * | | * | | 1 |
| d. [**ɑnɑɲcu**] | | | * | * | * | | ~~2~~ |
| e. [ɑ:ɾɑnt̪u] | * | * | | | | * | ~~1~~ |
| f. [ɑɾɑnt̪u] | | * | | * | | * | ~~2~~ |
| g. ☞[ɑ:nɑnt̪u] | * | | | | * | * | 2 |
| h. ☞[**ɑnɑnt̪u**] | | | | * | * | * | 3 |

Multiple optimal candidates are to be chosen by the child's grammar for reaching the target word /ɑccɑm/ and to show the processing patterns happened in a child's speech from **[ɑnɑɳʈ̪ɯ]**. Using OT, multiple candidates are selected according to the constraints in tableu (199).

i. For the selection of the next optimal candidate for the child's utterance **[ɑnɑɳʈ̪ɯ]**, candidates d. [**ɑnɑɲcu**], f. [ɑɾɑɳʈ̪ɯ], g. [ɑ:nɑɳʈ̪ɯ] which are equally having two faithfulness constraints are taken into account. Among the candidates d. [**ɑnɑɲcu**], f. [ɑɾɑɳʈ̪ɯ], and g. [ɑ:nɑɳʈ̪ɯ]; for the selection of the next optimal candidate, candidate [ɑ:nɑɳʈ̪ɯ] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [**ɑnɑɳʈ̪ɯ**].
So re-ranking is [**ɑnɑɳʈ̪ɯ**]> [ɑ:nɑɳʈ̪ɯ]
ii. For the selection of the next optimal candidate, Candidates b. [**ɑɾɑɲcu**], c. [**ɑ:nɑɲcu**], e. [ɑ:ɾɑɳʈ̪ɯ], which equally have one faithfulness constraint is taken into account. Among these, [**ɑɾɑɲcu**], is out of selection as the constraint *TENSE has been restrained in earlier selection. Among the other two candidates, c. [**ɑ:nɑɲcu**], and e. [ɑ:ɾɑɳʈ̪ɯ], candidate [**ɑ:nɑɲcu**] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate **[**ɑ:nɑɳʈ̪ɯ].
So the next step in the re-ranking is [**ɑnɑɳʈ̪ɯ**]> [ɑ:nɑɳʈ̪ɯ]> [**ɑ:nɑɲcu**]
iii. From this reranking, the next candidate is the input or underlying representation [**ɑ:ɾɑɲcu].**
So the final re-ranking is [**ɑnɑɳʈ̪ɯ**]> [ɑ:nɑɳʈ̪ɯ]> [**ɑ:nɑɲcu**]> [**ɑ:ɾɑɲcu**]
iv. So the **ReRanking** of constraints is **: *TENSE > *DORSAL-PALATAL > *LIQUID**
**(200) Ranking: *TENSE > *DORSAL-PALATAL > *LIQUID**

13. /ɑɲcukɑm/ > /ɑccɑpɑm/ **Target word:** /ɑɲcukɑm/ **Child's Utterance:** /ɑccɑpɑm/

(201) Constraints ranking tableau for the word /ɑɲcukɑm/

| /aɲcukam/ ‘parrot’ | *AGREE-PALATALSTOP | *HIGH | *VELAR | IDENT-MANNER | IDENT-HEIGHT | IDENT- PLACE | |
|---|---|---|---|---|---|---|---|
| a. [aɲcukam] | * | *! | * | | | | |
| b. [**aɲca**kam] | * | | * | | * | | 1 |
| c. ☞[**acca**kam] | | | * | * | * | | 2 |
| d. [**aɲcap**am] | * | | | | * | * | ~~2~~ |
| e. ☞ [**accu**kam] | | * | * | * | | | 1 |
| f. [**aɲcup**am] | * | * | | | | * | ~~1~~ |
| g. [accupam] | | * | | * | | * | ~~2~~ |
| h. ☞[accapam] | | | | * | * | * | 3 |

Multiple optimal candidates are to be chosen by the child’s grammar for reaching the target word /accam/ and to show the processing patterns happened in a child’s speech from **[**accapam**]**. Using OT, multiple candidates are selected according to the constraints in Tableu (201).

i. For the selection of the next optimal candidate for the child’s utterance **[**accapam**]**, candidates c. [**acca**kam], d.[**aɲcap**am], g. [accupam], which are equally having two faithfulness constraints, are considered. Among the candidates c. [**acca**kam], d. [**aɲcap**am], g. [accupam]; for the selection of the next optimal candidate, candidate [**acca**kam] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [accapam].
   So reranking is [accapam]> [**acca**kam]
ii. For the selection of the next optimal candidate, Candidates b.[**aɲca**kam], e. [**accu**kam], f. [**aɲcup**am], which equally have one faithfulness constraint, are taken into account. Among these, [**aɲcup**am] is out of selection as the constraint ***VELAR** has been restrained in earlier selection. Among the other two candidates, b. [**aɲca**kam], and e. [**accu**kam],

candidate [**accu**kɑm] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate **[acca**kɑm].

So the next step in the reranking is [accapɑm]> [**acca**kɑm]> [**accu**kɑm]

iii. From this reranking, the next candidate is the input or underlying representation [aɲcukɑm]**.**

So the final re-ranking is [accapɑm]> [**acca**kɑm]> [**accu**kɑm]> [aɲcukɑm]

iv. So the **ReRanking** of constraints is **: *VELAR > *HIGH >*AGREE-PALATALSTOP**

**(202) Ranking: *VELAR > *HIGH >*AGREE-PALATALSTOP**

**13. /pajirrunaɾ/>/pa:ʈʈanaɾ/** Target word:/pajirrunaɾ/ Child's Utterance: /pa:ʈʈanaɾ/

(203) Constraints ranking tableau for the word /pajirrunaɾ/

| /pampaɾam / 'Top' | *COMPLEX | *NASAL | *LIQUID | UNIFORMITY | IDENT-NASAL | IDENT-CONSONANT | |
|---|---|---|---|---|---|---|---|
| a. [pampaɾam] | * | * | * | | | | |
| b. [pampaʋam] | * | | * | | | * | 1 |
| c.☞[pammaɾam] (4) | * | ** | * | | * | | 1 |
| d.☞[paʋʋaɾam] (3) | * | | * | | * | * | 2 |
| e. [pammaʋam] | * | | | | * | * | ~~2~~ |
| f. ☞[paʋʋaʋam] (2) | * | | | | * | ** | 3 |
| g. [paʋaɾam] | | | * | * | * | | 2 |
| h.☞[paʋaʋam](1) | | | | * | * | ** | 4 |

Multiple optimal candidates are to be chosen by the child's grammar for reaching the target word /**pampaɾam**/ and to show the processing patterns happened in a child's speech from [**paʋaʋam**]. Using OT, multiple candidates are selected according to the constraints in tableau (203).

1. For the selection of the next optimal candidate for the child's utterance [paʋaʋam], only the candidate f. [paʋʋaʋam] has three faithfulness constraints. So, it is selected as the next optimal candidate for the child's utterance [paʋaʋam]
   So reranking is [paʋaʋam]>[paʋʋaʋam]
2. For the selection of the next optimal candidate, Candidates d. [paʋʋaɾam], e. [pammaʋam], g. [paʋaɾam], which are equally having two faithfulness constraints are taken into account. Here, candidate g. [paʋaɾam] has to be eliminated from the selection list as the constraint *COMPLEX has been restored with COMPLEX. Among the rest of 2, d. [paʋʋaɾam], e. [pammaʋam]; candidate [paʋʋaɾam] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [paʋʋa**ʋam].**
   So the next step in the reranking is [paʋaʋam]>[paʋʋaʋam] >[paʋʋaɾam]
3. For the selection of the next optimal candidate, Candidates b. [pampaʋam], and c. [pammaɾam], which equally have one faithfulness constraint, are taken into account. Among these, b. [pampaʋam] is out of selection as the constraint *LIQUID has been restrained in earlier selection. So candidate [pammaɾam] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [paʋʋaɾam]
   So the next step in the reranking is [paʋaʋam]>[paʋʋaʋam]> [paʋʋaɾam]> [pammaɾam]
4. From this reranking, the next candidate is the input or underlying representation **[**pampaɾam**].**
   So re-ranking is [paʋaʋam]>[paʋʋaʋam] >[paʋʋaɾam]>[pammaɾam]>[pampaɾam]
   **(204) Ranking: *COMPLEX > *NASAL >*LIQUID**

15. **aŋkam/> /aʈʈe:/** Target word: /aŋkam/ Child's Utterance: /aʈʈe:/

(205) Constraints ranking tableau for the word /aŋkam/ 'part'

| /ɑŋ.kɑm/ ‘part’ | *AGREE-STOP | *DORSAL | *CODA | *LOW (II Syll) | *LAX (II Syll) | IDENT-MANNER | IDENTPLACE | MAX | IDENT-HEIGHT (II Syll) | IDENT-LENGTH (II Syll) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| a. **[ɑŋkɑm]**(6) | *! | * | * | * | * | | | | | | |
| b. [ɑŋkɑ:m] | *! | * | * | * | | | | | | * | **1** |
| c. [ɑŋkem] | *! | * | * | | * | | | | * | | **1** |
| d. [ɑŋke:m] | *! | * | * | | | | | | * | * | **2** |
| e. [ɑŋke] | *! | * | | | * | | | * | * | | **2** |
| f. [ɑŋke:] | *! | * | | | | | | * | * | * | **3** |
| g. [ɑŋkɑ] | *! | * | | * | * | | | * | | | **1** |
| h. [ɑŋkɑ:] | *! | * | | * | | | | * | | * | **2** |
| i. ☞ [ɑkkɑm] (5) | | *! | * | * | * | * | | | | | **1** |
| j. [ɑkkɑ:m] | | *! | * | * | | * | | | | * | **2** |
| k. [ɑkkɑ] | | *! | | * | * | * | | * | | | **2** |
| l. [ɑkkɑ:] | | *! | | * | | * | | * | | * | **3** |
| m. [ɑkkem] | | *! | * | | * | * | | | * | | **2** |
| n. [ɑkke:m] | | *! | * | | | * | | | * | * | **3** |
| o. [ɑkke:] | | *! | | | | * | | * | * | * | **4** |
| p. [ɑkke] | | *! | | | * | * | | * | * | | **3** |
| q. ☞ [ɑt̪t̪ɑm] (4) | | | *! | * | * | * | * | | | | **2** |
| r. [ɑt̪t̪ɑ:m] | | | *! | * | | * | * | | | * | **3** |
| s. [ɑt̪t̪em] | | | *! | | * | * | * | | * | | **3** |
| t. [ɑt̪t̪e:m] | | | *! | | | * | * | | * | * | **4** |
| u. [ɑt̪t̪ɑ:] | | | | *! | | * | * | * | | * | **4** |
| v. ☞ [ɑt̪t̪ɑ] (3) | | | | *! | * | * | * | * | | | **3** |
| w. ☞ [ɑt̪t̪e] (2) | | | | | *! | * | * | * | * | | **4** |
| x. ☞ **[ɑt̪t̪e:](1)** | | | | | | * | * | * | * | * | **5** |

Multiple optimal candidates are to be chosen by the child’s grammar for reaching the target word /**ɑŋkɑm**/ and to show the processing patterns happened in a child's speech from **[ɑʈʈe:]**. Using OT, multiple candidates are selected according to the constraints in tableu (205).

i. For the selection of the next optimal candidate to the child's utterance [**ɑʈʈe:]**, Candidates w. [ɑʈʈe], u. [ɑʈʈɑ:], t. [ɑʈʈe:m], o. [ɑkke:], which are equally having four faithfulness constraints, are considered. Among those four, candidate [**ɑʈʈe**] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [**ɑʈʈe**:].
   So re-ranking is [**ɑʈʈe:**]**>[ ɑʈʈe]**
ii. For the selection of the next optimal candidate, Candidates f. [ɑŋke:], l. [ɑkkɑ:], n. [ɑkke:m], p. [ɑkke], r. [ɑʈʈɑ:m], s. [ɑʈʈem] and v. [ɑʈʈɑ], which are equally having three faithfulness constraints, are taken into account. Among seven candidates, candidates f. [ɑŋke:], l. [ɑkkɑ:], n. [ɑkke:m], r. [ɑʈʈɑ:m] has to be eliminated from the selection list as the constraint *LAX has to be has been restored with LAX. Among the rest of the three, p. [ɑkke], s. [ɑʈʈem], v. [ɑʈʈɑ], candidate [ɑʈʈɑ] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [**ɑʈʈe**].
   So re-ranking is [**ɑʈʈe:**]**>[ɑʈʈe] >[ɑʈʈ**ɑ**]**
iii. For the selection of the next optimal candidate, Candidates d. [ɑŋke:m], e. [ɑŋke], h. [ɑŋkɑ:], j. [ɑkkɑ:m], k. [ɑkkɑ], m. [ɑkkem], q. [ɑʈʈɑm], which are equally having two faithfulness constraints are taken into account. Here are the candidates: d. [ɑŋke:m], h. [ɑŋkɑ:], j. [ɑkkɑ:m], have to be eliminated from the selection list as the constraint *LAX has been restored with LAX and candidates e. [ɑŋke], m. [ɑkkem] must be eliminated from the selection list as the constraint *LOW has been restored with LOW. Among the rest of the two, k. [ɑkkɑ], q. [ɑʈʈɑm]; candidate [ɑʈʈɑm] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [ɑʈʈɑ]
   So the next step in the re-ranking is [**ɑʈʈe:**]**>[ ɑʈʈe] >[ɑʈʈ**ɑ**] >[ɑʈʈ**ɑm**]**
iv. For the selection of the next optimal candidate, Candidates b.

[aŋka:m], c. [aŋkem], g. [aŋka], i. [akkam], which equally have one faithfulness constraint, are taken into account. Among these four; b. [aŋka:m] is out of selection as the constraint LAX has been restrained in earlier selection; c. [aŋkem] is out of selection as the constraint LOW has been restrained in earlier selection; and g. [aŋka] is out of selection as the constraint CODA has been restrained in earlier selection. So, candidate [akkam] has been selected as the next optimal candidate to the previous optimal candidate [**at̪t̪**am].

So the next step in there-ranking is [**at̪t̪e:**]>[ **at̪t̪e**]>[**at̪t̪**a]>[**a t̪t̪**am]>[**akkam**]

v. From this reranking, the next candidate is the input or underlying representation **[aŋkam].**

So the final re-ranking is [**at̪t̪e:**]>[ **at̪t̪e**]>[**at̪t̪**a]>[**at̪t̪**am]>[**a kkam**] >[**aŋkam**]

vi. **So the reranking of constraints is *LAX>*LOW >*CODA>*DORSAL>*AGREE-STOP.** Here, the method of analysis has to be reversed for the intervention purpose.

**(206) Ranking : *LAX>*LOW >* CODA>* DORSAL> *AGREE-STOP**

16. /vent̪ajam/>/ve:vavam/ **Target word:** /vent̪ajam/ **Child's Utterance:** /ve:vavam/

(207) **Constraints ranking tableau for the word** /vent̪ajam /

| /vent̪ajam / 'fenugreek' | *LAX | *COMPLEX | *STOP | *DORSAL-PALATAL | IDENT-LENTGH | MAX | IDENT-MANNER | IDENT-PLACE | |
|---|---|---|---|---|---|---|---|---|---|
| a. [vent̪ajam](5) | *! | * | * | * | | | | | 0 |
| b. [ve:nt̪ajam] | | *! | * | * | * | | | | 1 |
| c. [ve:t̪t̪ajam] | | * | **! | * | * | | * | | 2 |
| d. [ve:nt̪avam] | | *! | * | | * | | | * | ~~2~~ |
| e. [ve:t̪ajam] | | | *! | * | * | * | | | 2 |
| f. [vent̪avam] | *! | * | * | | | | | * | ~~1~~ |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| g.☞[ʋet̪ajam] (4) | *! | | * | * | | * | | | 1 |
| h. [ʋet̪aʋam] | *! | | * | | | * | | * | ~~2~~ |
| i. [ʋet̪t̪ajam] | * | * | **! | * | | | * | | 1 |
| j. [ʋet̪t̪aʋam] | * | * | **! | | | | * | * | ~~2~~ |
| k.☞ [ʋeʋajam] (3) | *! | | | * | | * | * | | 2 |
| l. ☞ [ʋeʋaʋam] (2) | *! | | | | | * | * | * | 3 |
| m. [ʋe:ʋajam] | | | | *! | * | * | * | | 3 |
| n. [ʋe:t̪t̪aʋam] | | * | **! | | * | | * | * | ~~3~~ |
| o. [ʋe:t̪aʋam] | | | *! | | * | * | | * | ~~3~~ |
| p. ☞[ʋe:ʋaʋam] (1) | | | | | * | * | * | * | 4 |

Multiple optimal candidates are to be chosen by the child's grammar for reaching the target word /**ʋen̪t̪ajam**/ and to show the processing patterns happened in a child's speech from [**ʋe:ʋaʋam**]. Using OT, multiple candidates are selected according to the constraints in tableu (207).

i. For the selection of the next optimal candidate, Candidates l. [**ʋeʋaʋam**], m. [ʋe:ʋajam], n. [ʋe:t̪t̪aʋam], o. [ʋe:t̪aʋam] which are equally having three faithfulness constraints are taken into account. Among four candidates, candidate n. [ʋe:t̪t̪aʋam] has three markedness constraints, so it is out of optimality. Among other three l. [**ʋeʋaʋam**]m. [ʋe:ʋajam], o. [ʋe:t̪aʋam], **[ʋeʋaʋam]** is selected as optimal because it is near sonorous to [**ʋe:ʋaʋam**] the child's utterance
   So re-ranking is [**ʋe:ʋaʋam**]>**[ʋeʋaʋam]**
ii. For the selection of the next optimal candidate, Candidates; k. [ʋeʋajam], j. [ʋet̪t̪aʋam], h.[ʋet̪aʋam], e. [ʋe:t̪ajam], d. [ʋe:n̪t̪aʋam], c. [ʋe:t̪t̪ajam], and b. [ʋe:n̪t̪ajam] which are equally having two faithfulness constraints taken into account. Here are the candidates, e. [ʋe:t̪ajam], d. [ʋe:n̪t̪aʋam], c. [ʋe:t̪t̪ajam], b. [ʋe:n̪t̪ajam] have to be eliminated from the selection list as the constraint *LAX has to be restored with

LAX. Among the rest of the three, k. [ʋeʋajam], j. [ʋeʈʈaʋam], h. [ʋeʈaʋam]; candidate j. [ʋeʈʈaʋam] has three markedness constraints, so they were eliminated from the selection list. Among the rest of 2, k. [ʋeʋajam], h. [ʋeʈaʋam]; candidate [ʋeʋajam] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate **[ʋeʋaʋam]**

So the next step in the re-ranking is [**ʋe:ʋaʋam**]>**[ʋeʋaʋam]**> [ʋeʋajam]

iii. For the selection of next optimal candidate, Candidates i.[ʋeʈʈajam], g.☞[ʋeʈajam], f. [ʋeɳʈaʋam], b. [ʋe:ɳʈajam], which equally have one faithfulness constraint, are taken into account. Among these, f. [ʋeɳʈaʋam] is out of selection as the constraint *DORSAL-PALATAL has been restrained in earlier selection. So among i.[ʋeʈʈajam], g. [ʋeʈajam], and b. [ʋe:ɳʈajam], candidate [ʋeʈajam] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [ʋeʋajam]

So the next step in there-ranking is [**ʋe:ʋaʋam**]>**[ʋeʋaʋam]**> [ʋeʋajam]> [ʋeʈajam]

iv. From this reranking, the next candidate is the input or underlying representation **[ʋeɳʈajam].**

So the final re-ranking is [**ʋe:ʋaʋam**]>**[ʋeʋaʋam]**>[ʋeʋaja m]>[ʋeʈajam]> **[ʋeɳʈajam]**

**(208) Ranking: *LAX > DORSAL-PALATAL>*STOP > *COMPLEX**

**17. /pajirrunaɾ/>/pa:ʈʈanaɾ/ Target word: /pajirrunaɾ/ Child's Utterance: /pa:ʈʈanaɾ/**

(209) Constraints ranking tableau for the word /pajirrunaɾ/

| /pajirrunaɾ/ 'trainer' | *LAX | *SYLLABLE | *LIQUID | *HIGH | IDENT-LENGTH | MAX | IDENT-MANNER | IDENT-HEIGHT | |
|---|---|---|---|---|---|---|---|---|---|
| a. [pajirrunaɾ] | *! | * | * | * | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| b. [pajirranar] | * | * | * | | | | | * | 1 |
| c. [pa:jirrunar] | | * | * | * | * | | | | 1 |
| d. [pa:jirranar] | | * | * | | * | | | * | ~~2~~ |
| e. ☞ [pajiʈʈanar] (3) | * | * | | | | | * | * | 2 |
| f. ☞ [pajiʈʈunar] (4) | * | * | | * | | | * | | 1 |
| g. [pa:jiʈʈanar] | | * | | | * | | * | * | ~~3~~ |
| h. [pa:jiʈʈunar] | | * | | * | * | | * | | 2 |
| i. [pa:rrunar] | | | * | * | * | * | | | 2 |
| j. [pa:ʈʈunar] | | | | * | * | * | * | | 3 |
| k. [pa:rranar] | | | * | | * | * | | * | ~~3~~ |
| l. [parrunar] | * | | * | * | | * | | | 1 |
| m. [parranar] | * | | * | | | * | | * | 2 |
| n. [paʈʈunar] | * | | | * | | * | * | | 2 |
| o. ☞ [paʈʈanar] (2) | * | | | | | * | * | * | 3 |
| **p.** ☞[pa:ʈʈanar] (1) | | | | | * | * | * | * | 4 |

Multiple optimal candidates are to be chosen by the child's grammar for reaching the target word /pajirrunar/ and to show the processing patterns happened in a child's speech from [pa:ʈʈanar]. Using OT, multiple candidates are selected according to the constraints in tableu (209).

i. For the selection of the next optimal candidate of the child's utterance [pa:ʈʈanar], Candidates g. [pa:jiʈʈanar], j. [pa:ʈʈunar], k. [pa:rranar], o. [paʈʈanar] which are equally having three faithfulness constraints are taken into account. Among these four candidates, candidate [paʈʈanar**]** is selected as optimal because it is near sonorous to the child's utterance [pa:ʈʈanar]
   So re-ranking is [pa:ʈʈanar]>**[** paʈʈanar**]**
ii. For the selection of the next optimal candidate, Candidates d. [pa:jirranar], e. [pajiʈʈanar], h. [pa:jiʈʈunar], i. [pa:rrunar], m. [parranar], n. [paʈʈunar], which are equally having two faithfulness constraints are taken into account. Here, the candidates d. [pa:jirranar], h. [pa:jiʈʈunar], and i. [pa:rrunar]

have to be eliminated from the selection list as the constraint *LAX has been has been restored with LAX. Among the rest of the three, e. [pɑjiʈʈanɑɾ], m. [pɑrranɑɾ], n. [pɑʈʈunɑɾ]; candidate e. [pɑjiʈʈanɑɾ] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate **[**pɑʈʈanɑɾ**]**

So the next step in the re-ranking is [pɑːʈʈanɑɾ]>**[** pɑʈʈanɑɾ**]**>[pɑjiʈʈanɑɾ]

iii. For the selection of next optimal candidate, the candidates b. [pɑjirranɑɾ], c. [pɑːjirrunɑɾ], f. [pɑjiʈʈunɑɾ], and l. [pɑrrunɑɾ], which equally have one faithfulness constraint, are considered. Among these, c. [pɑːjirrunɑɾ] is out of selection as the constraint *LAX has been restrained in the earlier selection and l. [pɑrrunɑɾ] is out of selection as the constraint *SYLLABLE has been restrained in earlier selection. So among b. [pɑjirranɑɾ], and f. [pɑjiʈʈunɑɾ], candidate [pɑjiʈʈunɑɾ] has been selected as the next optimal candidate as it is near sonorous to previous optimal candidate [pɑjiʈʈanɑɾ]

So the next step in there-ranking is [pɑːʈʈanɑɾ]>**[** pɑʈʈanɑɾ**]**>[pɑjiʈʈanɑɾ]>[pɑjiʈʈunɑɾ]

iv. From this reranking, the next candidate is the input or underlying representation [pɑjirrunɑɾ]**.**

v. So the final re-ranking is [pɑːʈʈanɑɾ]>**[**pɑʈʈanɑɾ**]**> [pɑjiʈʈanɑɾ]>[pɑjiʈʈunɑɾ] >[pɑjirrunɑɾ]

**(210) Ranking: *LAX > *SYLLABLE > *HIGH > *LIQUID**

## Post-Script

The description of segmental changes in surface form from underlying form for the above data shows the hypothetical chain shifts of phonemes in each stage. So, the child's phonological development may be moved in the reverse order traced in each data. Considering this hypothetical derivation, the reverse order tracking of optimal candidates from the surface (child's) to underlying (input) is done with the data of children with phonological disorders. It provides the intervention model for children with Mental Retardation, Cerebral Palsy and Autism.

The intervention modules were planned on the basis of an "Individualized Educational Plan (IEP)" for each word and downgrading of each markedness constraint to restrain the error patterns one by one using the Optimality Theory. We were most interested in the child's performance relating to the error patterns described above. As soon as the data has been collected from the children and analysed, the words with multi-phoneme deviances have been documented separately along with the meta-data of the child. Then, the children's parent/ caretaker has been approached for the continuity of the therapy and taking-home plan in the given procedure. The planned module for the words has been implemented and checked for efficacy. The child reached the target utterance in one stretch with a hypothetical assumption of phonological transitions in phonological development made in the intervention module. On the day of peri therapy (the first day) itself, the child was able to utter the word appropriately, but the degree of accuracy varied according to the disability and severity of the phonological disorder.

Table 19

| Level of Phonological Disorders in Children (according to the no of phoneme deviance in a word) | Accuracy in % Pre | Accuracy in % Peri |
|---|---|---|
| Mild (one to two) | 70 | 90-100 |
| Moderate (three) | 50 | 80-90 |
| Severe (four and above) | 30 | 70-80 |

Also, OT works successfully for multi-phoneme deviance of children with three disorders (Cerebral Palsy, Mental Retardation, and Autism). This led to a look into the consistency of speech after the intervention and the duration taken by the children to reach consistency. Also, as it shows a universal pattern in faithfulness constraints among normative data and data with children with disorders and the intervention pattern works on the basis of chin shifting with sonority principle and universal pattern of phonological acquisition, it is assumed that this intervention can also work for other Indian languages too. So, the duration for the consistency in speech and applicability to other Indian languages has also been investigated and described in the following chapter.

s

CHAPTER – 6

# Comprehensive Applicability of OT

## 6.1. Duration of the Consistency in Speech

The applicability of OT aims to have an immediate and direct implication for selecting a treatment target, which is an attempt to restrain an error pattern. To start with, restraining any error pattern needs the downgrading of a markedness constraint. So, the intervention module prescribed in the previous chapter clearly specifies how each constraint can be restrained one by one to reach the target word.

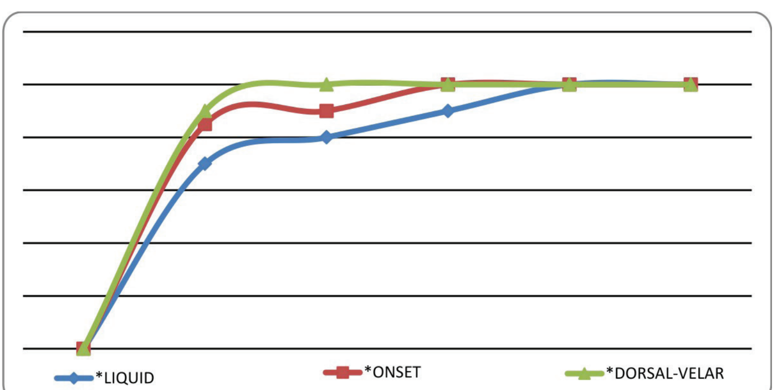
The predictions of this alternative technique are evaluated in the treatment study and are described further.

Child **'A'** (with Mental Retardation) was joined in a remediation study that was planned to suppress the error patterns. A sample programme for the word /cɑkkɑɾɑm/, which has been mispronounced as [ɑccɑjɑm], has been described here. The constraints for the erred pattern are *LIQUID, *ONSET, and *DORSAL-VELAR. The treatment was planned by focusing on the derived source for that error pattern, namely *LIQUID, *ONSET, *DORSAL-VELAR. Treatment was structured around eight forms: seven were nonwords, and one was target utterance (190). Out of which, one target word and three nonwords have been selected as optimal (along with an utterance of the Child).

- **So the Treatment stimuli planned is:**
  [accajam]>[accaɾam]>[akkaɾam]> [cakkaɾam]

The child uttered the nonwords in imitation of the adult model. The accuracy was documented for pre-treatment and during the first/peri treatment. The Child was given treatment for a one-hour session three times a week by the Speech Language Pathologist (SLP). Treatment proceeded in two segments, with corrective feedback provided about the accuracy of productions by the SLP and the mother/caretaker of the Child. The home plan design was also devised to go after the treatment at home, which is scheduled six times a day. So, the Child has to undergo 42 sessions per week. After 10 days, it's reduced to three sessions a day, and after 15 days, one session a day. Also, generalization was defined as the transfer of learning from performance on treated nonwords to untreated real words. The first interval (Pre) represents baseline pre-treatment performance. The second interval (Peri) refers to the point of the first treatment. The remaining four intervals reflect post-treatment performance on the probes immediately after a week of treatment, then again at ten days, then again at two weeks, and a month after.

The results from the study are plotted in Graph 3. On the y-axis, separate functions are plotted to document each error pattern's




Graph 3

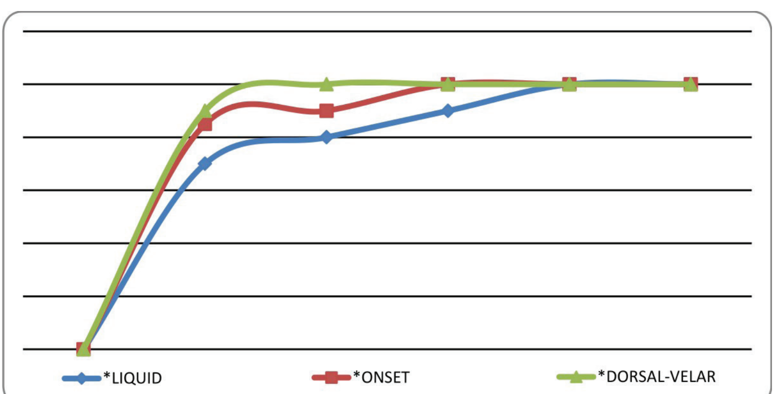
percent accuracy. The sampling intervals for the investigation are represented on the x-axis.

A decline in the error pattern's function over time indicates that that particular error pattern was decreasing in its percent occurrence, and the accuracy of pronunciation of that phoneme increases. The Child 'A' was able to get 100 per cent accuracy by the 15th day of the treatment procedure.

Child 'B' (with Autism) was joined in a remediation study that was planned to suppress the error patterns. A sample program for the word /ɑŋkɑm/, which has been mispronounced as [ɑccɑjɑm], has been described here. The constraints for the erred pattern are *LIQUID, *ONSET, and *DORSAL-VELAR. The treatment was planned by focusing on the derived source for that error pattern, namely *LIQUID, *ONSET, *DORSAL-VELAR. Treatment was structured around a set of twenty-four forms, where 23 were nonwords, and one was target utterance (197). Out of which, one target word and five nonwords have been selected as optimal (along with an utterance of the Child).

- **So the treatment stimuli planned is:**
  [**ɑt̪t̪e**ː] > [**ɑt̪t̪e**] > [**ɑt̪t̪**ɑ] > [**ɑt̪t̪**ɑm] > [**ɑkkɑm**]>[**ɑŋkɑm**]

Further the treatment plan proceeded as such for the previous samples and results from the study are plotted in Graph 4.



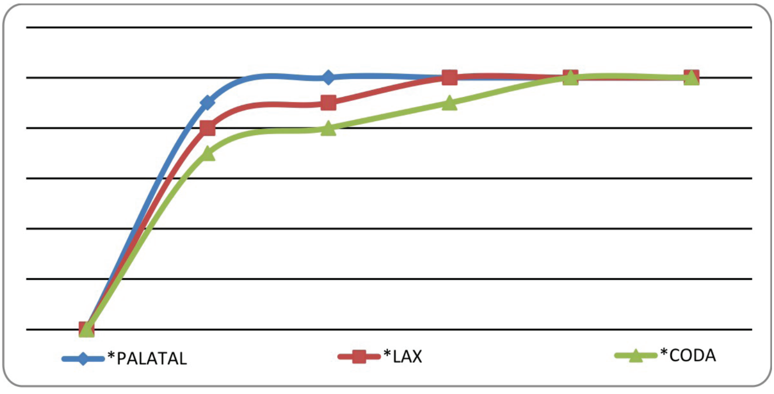

Graph 4

Child B also shows a decline in the error pattern's function over time. However, he had more constraints, and the pronunciation accuracy of that phoneme increased gradually and took a month for complete accuracy. Child 'B' was able to get the 100 per cent accuracy that is consistent in speech regarding the above constraints by the 30th day (a month after) of the treatment procedure.

Child 'C' (with Cerebral Palsy) was joined in a remediation study that was planned to suppress the error patterns. A sample programme for the word /ɑccɑm/, which has been mispronounced as [ɑt̪t̪ɑ:], has been described here. The constraints for the erred pattern are *PALATAL, *LAX, *CODA. The treatment was planned by focusing on the derived source for that error pattern, namely *PALATAL, *LAX, *CODA. Treatment was structured around a set of eight forms, where seven were nonwords, and one was target utterance (193). Out of which, one target word and three nonwords have been selected as optimal (along with an utterance of the Child).

- **So the treatment stimuli planned is:** [ɑt̪t̪ɑ:] > [ɑt̪t̪ɑ] > [ɑccɑ] > [ɑccɑm]

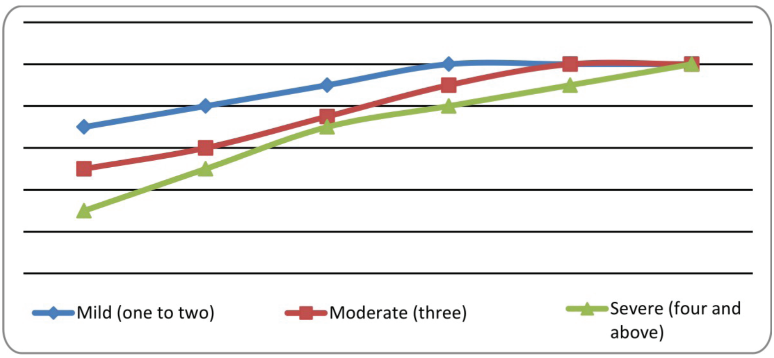
Further, the treatment plan proceeded as such for the previous sample, and results from the study are plotted in Graph 5.




Graph 5

Child ‘B’ was able to get 100 per cent accuracy, which is consistency in speech regarding the constraints mentioned above, by 15th days of the treatment procedure.

So, the analysis of the intervention procedure for the data of the above three samples gives the picture that the Child was able to approximate the target utterance on the first day of the treatment procedure and to get consistency, it depends on the severity of the phonological problem. Subsequently, Graph 6 illustrates the result of the analysis of duration of constancy on the basis of the severity of the disorder.




Graph 6

So from the analysis, it is inferred that the Child with mild problems gets consistency within ten days of time, whereas it takes 15 days for a child with moderate issues. However, the Child with severe phonological disorders, i.e., a child with mental retardation with severe phonological delay, uttered in a pre-treatment period as /m. ɑm/ for the target word /pɑmpɑɾɑm/ ‘top’, took a month period to get the consistency.

## 6.2. Applicability to other Indian Languages

As mentioned in the postscript of the previous chapter, the theoretical framework provided the idea that this intervention can also work for other Indian languages. So, an attempt has been made to frame intervention procedures for a few other Indian languages like Kannada, Telugu, Hindi, and Nativised English words.

### *6.2.1. Kannada*

Data has been collected from a four-year-old child with delayed speech and language (DSL), and sample data has been described here.

**Target word:** /gaɖija:ɾa:/**Child's Utterance:** /gajija:ja:/

(200) Constraints ranking tableau for the word /ṯinʈa:ʈʈam/

| /gaɖija:ɾa:/ 'Clock' | *STOP | *LIQUID | IDENT-CONSONANT | |
|---|---|---|---|---|
| a. [gaɖija:ɾa:] | * | *! | | |
| b. [gajija:ɾa:] | | * | * | ~~1~~ |
| c. ☞[gaɖija:ja:] | * | | * | 1 |
| d. ☞[gajija:ja:] | | | ** | 2 |

Multiple optimal candidates are to be chosen by the Child's grammar for reaching the target word /gaɖija:ɾa:/ and to show the processing patterns happened in a child's speech from [gajija:ja:]. Using OT, multiple candidates are selected according to the constraints in tableus (200).

i. For the selection of the next optimal candidate for the Child's utterance [gajija:ja:], candidates [gajija:ɾa:] and [gaɖija:ja:] are having one faithfulness constraint. However, candidate [gaɖija:ja:] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [gajija:ja:].
   So re-ranking is [gajija:ja:]> [gaɖija:ja:]
ii. From this re-ranking, the next candidate is the input or underlying representation [gaɖija:ɾa:].
   So the final re-ranking is [gajija:ja:]> [gaɖija:ja:]> [gaɖija:ɾa:]
iii. So the **ReRanking** of constraints is**: *STOP >*LIQUID**

### *6.2.2. Telugu*

Data has been collected from a 8;5 year-old child with delayed speech and language (DSL) and Hearing Impairment (HI); a sample data has been described here.

**Target word:** /mɑ:miɖi/ **Child's Utterance:** /pɑ:pi/

(201) Constraints ranking tableau for the word /mɑ:miɖi/

| /mɑ:miɖi/ 'Mango' | ***NASAL** | ***SYLLABLE** | **IDENT-NASAL** | MAX | |
|---|---|---|---|---|---|
| a. [mɑ:miɖi] | **! | * | | | 0 |
| b. [mɑ:mimi] | ** | * | | | 0 |
| c. ☞[mɑ:mi] | ** | | | * | 1 |
| d. ☞[pɑ:pi] | | | ** | * | 3 |

Multiple optimal candidates are to be chosen by the Child's grammar for reaching the target word /mɑ:miɖi/ and to show the processing patterns that happened in a child's speech from **[**pɑ:pi**]**. Using OT, multiple candidates are selected according to the constraints as in tableu 201.

i. For the selection of the next optimal candidate to the Child's utterance **[**pɑ:pi**]**, only candidate [mɑ:mi] has one faithfulness constraint, which can be taken for the selection of the next optimal candidate to that of the previous optimal candidate [pɑ:pi].
   So re-ranking is [pɑ:pi]> [mɑ:mi]
ii. For the selection of the next optimal candidate, candidate [mɑ:mimi] has no faithfulness constraint but has one phoneme variation which can connect the previous optimal candidate **[**mɑ:mi] and the final candidate/underlying representation [mɑ:miɖi].
   So the next step in the re-ranking is [pɑ:pi]> [mɑ:mi]> [mɑ:mimi]
iii. From this re-ranking, the next candidate is the input or underlying representation [mɑ:miɖi]**.**

So the final re-ranking is [pɑ:pi]> [mɑ:mi]> [mɑ:mimi]> [mɑ:miḍi]
So the **ReRanking** of constraints is**: *NASAL > *SYLLABLE**

### *6.2.3. Hindi*

Data has been collected from a 24-year-old adult lady with Apraxia, and sample data has been described here.

**Target word:** /t̪ɑkni:k/ **Child's Utterance:** /t̪ɑtni:t/

(202) Constraints ranking tableau for the word /t̪ɑkni:k/

| /t̪ɑkni:k/ 'technique' | *VELAR | AGREE-VELAR | IDENT-PLACE | |
|---|---|---|---|---|
| a. [t̪ɑkni:k] | *! | | | |
| b. ☞[t̪ɑkni:t̪] | * | | | 1 |
| c. [t̪ɑt̪ni:k] | | | * | ~~1~~ |
| d. ☞[t̪ɑt̪ni:t̪] | | | * | 2 |

Multiple optimal candidates are to be chosen by the Child's grammar for reaching the target word /t̪ɑkni:k/ and to show the processing patterns happened in a child's speech from **[t̪ɑt̪ni:t̪]**. Using OT, multiple candidates are selected according to the constraints as in tableu (202).

i. For the selection of the next optimal candidate to the Child's utterance **[t̪ɑt̪ni:t̪]**, candidates [t̪ɑkni:t̪] and [t̪ɑt̪ni:k] have one faithfulness constraint. However, candidate [t̪ɑkni:t̪] has been selected as the next optimal candidate as it is nearly sonorous to the previous optimal candidate [t̪ɑt̪ni:t̪].
   So re-ranking is [t̪ɑt̪ni:t̪]> [t̪ɑkni:t̪]
ii. From this re-ranking, the next candidate is the input or underlying representation [t̪ɑkni:k]**.**
   So the final re-ranking is [t̪ɑt̪ni:t̪]> [t̪ɑkni:t̪]> [t̪ɑkni:k]
iii. So the **ReRanking** of constraints is**: *VELAR >*AGREE-VELAR**

### *6.2.4. Nativised (Indian) English*

Data has been collected from a four-year-old child with delayed speech and language (DSL), and sample data has been described here.

**Target word:** /ɾe:ɖijo/ **Child's Utterance:** /e:jijo/

(203) Constraints ranking tableau for the word /ɾe:ɖijo/

| /ɾe:ɖijo/ 'Radio' | ***ONSET** | ***CORONAL-RETROFLEX** | **MAX** | **IDENT-MANNER** | |
|---|---|---|---|---|---|
| a. [ɾe:ɖijo] | *! | * | | | |
| b. [ɾe:jijo] | * | | | * | ɨ |
| c. ☞[e:ɖijo] | | * | * | | 1 |
| b. ☞[e:jijo] | | * | * | * | **2** |

Multiple optimal candidates are to be chosen by the Child's grammar for reaching the target word /ɾe:ɖijo/ and to show the processing patterns that happened in a child's speech from [e:jijo]. Using OT, multiple candidates are selected according to the constraints in tableu 203.

i. For the selection of the next optimal candidate for the Child's utterance [e:jijo], candidates [ɾe:jijo] and [e:ɖijo] have one faithfulness constraint. However, candidate [e:ɖijo] has been selected as the next optimal candidate as it is near sonorous to the previous optimal candidate [e:jijo].
   So re-ranking is [e:jijo]> [e:ɖijo]
ii. From this re-ranking, the next candidate is the input or underlying representation [ɾe:ɖijo]**.**
   So the final re-ranking is [e:jijo]> [e:ɖijo]> [ɾe:ɖijo]
iii. So the **ReRanking** of constraints is**:** ***ONSET >*CORONAL-RETROFLEX**

### 6.3. Suggestions for Further Research

The point of view of this study suggests some appealing possibilities for further research.

First among these must be the implications of this approach for the analysis of acquisition phenomena has to provide the chain shift pattern of children, also can find out if there is any universal patterning among children in the chain shift. The fact that chain shift patterns are amenable to such a grammatical analysis is particularly significant given that some previous accounts of these scenarios have argued that they are solely attributable to functional, extralinguistic requirements such as Weinberger's (1987, 1994) Recoverability Principle.

Next, to find out the applicability of this intervention for many other disorders that lead to phonological disorders.

The intervention procedure can be carried out for many samples with one another parameter of various disabilities.

Also, the study has to be focused on people with PD at different age levels, and its impact on the phonology and duration of intervention can be checked.

There should be a study on framing a universal formula for finding the optimal candidates using combinatorics.

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