REVIEW OF LITERATURE
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Speech and language is the most extensively used means of communication, and individuals with speech and language disorders constitute a large percentage of those with communicative difficulties. When we come across communication disorders in clinical practice, there is a necessity to know the distinctions between the two important core conceptions, articulation disorder and phonological disorder. Articulation disorder dates back to the early foundations of what is now designated communication disorders whereas the term, phonological disorder is a more recent one demonstrating the influence of linguistics on this field of study.

Articulation refers to the totality of motor processes involved in the planning and execution of sequences of overlapping gestures that result in speech (Fey, 1992) (Cited in Bauman-Waengler, 2004). According to Fey (1992), this definition implies that, first the learning of articulatory skills is an acquisitional process involving the gradual development of the ability to move the articulators in a precise and rapid manner. Second, the definition implies that errors in articulation must be seen as relatively peripheral disturbances of articulatory processes. Therefore, peripheral motor process, not central linguistic abilities are impaired. An articulation disorder refers to difficulties with motor production aspects of speech, or an inability to produce certain speech sounds (Elbert & Gierut, 1986) (Cited in Bauman-Waengler, 2004). Articulation disorders represent deficiencies in the relatively peripheral motor processes that result in speech.
The term phonology is basic to the understanding of phonological disorders. Phonology includes the inventory of phonemes of the language. Phonology is the study of how phonemes are organized and function in communication (Lowe, 1994). Phonological disorder refers to an impaired system of phonemes and phoneme patterns within the context of spoken language. The term represents an individual’s impairment of the representation and organization of phonemes within the language system.

Differences between articulation disorders and phonological disorders given by Bauman-Waengler (2004) are listed in the Table 1:

<table>
<thead>
<tr>
<th>Articulation Disorders</th>
<th>Phonological Disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Phonetic errors</td>
<td>Phonemic errors</td>
</tr>
<tr>
<td>2 Problems in speech sound production</td>
<td>Problems in the language specific function phonemes</td>
</tr>
<tr>
<td>3 Difficulties with speech sound form</td>
<td>Difficulties with phoneme function</td>
</tr>
<tr>
<td>4 Disturbances in relatively peripheral motor processes that result in speech</td>
<td>Disturbances represent an impairment of representation /organization of phonemes within the language system.</td>
</tr>
<tr>
<td>5 Speech sound production difficulties do not typically impact other areas of language development such as morphology, syntax, or semantics</td>
<td>Phoneme difficulties may impact other language areas such as morphology, syntax, or semantics</td>
</tr>
</tbody>
</table>

In order to understand phonological disorders, there is a need to know the phonological development in normal children. Phonological development has great relevance for the clinical population to determine whether a child is phonologically disordered and needs professional help.
DEVELOPMENT OF PHONOLOGY

Phonological development refers to the acquisition of speech sound form and function within the language system. Speech sound development refers primarily to the gradual articulatory mastery of speech sound forms within a given language. A child's language development is commonly divided into pre-linguistic behavior, vocalizations prior to the first true words and linguistic development, which starts with the appearance of these first words. The following is an overview of the pre-linguistic stages of production described by Stark (1986) (Cited in Bauman-Waengler, 2004):

Stage I: Reflexive crying and vegetative sounds (birth to 2 months).

- Birth to one month is also considered as phonation stage.
- Reflexive vocalizations such as crying, fussing coughing, sneezing, burking are predominated. They seem to be automatic responses reflecting the physical state of an infant.
- Vegetative sounds may be divided into grunts, sighs associated with activity and clicks, for example, which are associated with feeding.
- Some non-reflexive vocalizations resembling syllabic nasals occur.
- Speech-like sounds are rare. However, vocalizations resembling vowels occur.

Stage II: Cooing and laughter (2 to 4 months) / Coo and Goo stage (2-3 months).

- During this stage, cooing or goooing sounds are produced during comfortable states. Although these sounds are sometimes referred to as vowel-like, they
also contain brief periods of consonantal elements that are produced at the back of the mouth.

- Sounds are produced that are acoustically similar to back vowels and consonant vowel (CV) and consonant (VC) syllables containing back vowels and back consonants (velars and uvulars).
- From 12 weeks onwards, a decrease in the frequency of crying is noted and more infant's primitive sounds start to disappear. At 16 weeks, sustained laughter emerges.

Stage III: Vocal play (4-6 months)

- Also called as Exploration - Expansion stage
- Is characterized as a period of vocal play in which the child gains better control of the laryngeal and articulatory mechanisms.
- The distinguishing characteristics of this stage include longer series of segments and the production of prolonged vowel or consonant like steady state along with variations in pitch and loudness.
- In contrast to vowels in stage II, this stage demonstrates more variation in tongue height and position. Squeals, growls, yells, raspberries, vowel like elements and friction noise may be observed in this stage. Predominant vocalization may vary daily and weekly.
- Vowels have better oral resonance and are more adult like.
Stage IV: Canonical Babbling Stage (7-9 months /6 months and older)

Stark (1986) (Cited in Bauman-Waengler, 2004) described this stage as a stage marked by similar strings of consonant vowel production. This is a collective term for the reduplicated and non-reduplicated babbling stages.

Reduplicated babbling stage (7-9 months) is characterized by the following features:

- There are slight quality variations in the vowel production of these strings of babbles. But the consonant will remain the same from syllable to syllable.
- Development of CV syllables continues and sounds are more constricted and resonated so that they now resemble true consonants and vowels.
- CV syllables become longer at this point and may be reduplicated.

Non-reduplicated babbling stage or Variegated babbling stage (9-10 months):

- Demonstrates variation of both consonants and vowels from syllable to syllable and is characterized by varying consonant and vowel productions from one syllable string to another. It combines a variety of CV sequence.
- Infant's vowel and consonant repertoire increases significantly at this point and intonation patterns take on a more adult like quality especially as the first year approximates.
- Smooth transition can be noted between vowel and consonant productions.

Stage V: Jargon Stage (10 months and older)

- This stage is also referred as conversation babble, modulated babble and often overlaps with the first meaningful words.
• It is characterized by strings of babbled utterances that are modulated primarily by intonation, rhythm and pausing (Crystal, 1986) (Cited in Bauman-Waengler, 2004).

• It sounds as if the child is actually attempting sentences.

• Many jargon vocalizations are delivered with eye contact, gestures and intonation patterns that resemble statements or questions.

Several studies suggest that babbling and early words have much in common. They are often so similar that difficulties arise in differentiating between the two. The main characteristics of the transition from babbling to first words include: primarily monosyllabic utterances, frequent use of stop consonants followed by nasals and fricatives, bilabial and rare use of consonant clusters, frequent use of central, mid-front and low front vowels.

First Fifty Words

Around a child's first birthday, a new development era begins: the linguistic phase. It starts the moment the first meaningful word is produced. First word is an entity of relatively stable phonetic form that is produced consistently by the child in a particular context and is recognizably related to the adult like word form of particular language (Owens 2001) (Cited in Bauman-Waengler, 2004). Children frequently use "invented words" in a consistent manner, thereby demonstrating that they seem to have meaning for the child. These vocalization are used consistently but without a recognizable adult model which is referred as phonetically consistent forms or vocables or proto-words or quasi words. The time of initial production of words is
usually called the first fifty words stage. The child begins to put two words together at approximately 18-24 months. The child produces approximately fifty meaningful words before the two-word stage begins.

**Acquisition of speech sound production**

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

- In the early years, diphthongs, vowels, consonants, double consonants blends and triple consonant blends are produced in most to least accurate order.
- The consonants are produced in the following order-nasals, plosives, fricatives and semi-vowels.
- The voiceless consonant elements are produced more accurately then voiced ones.
- By eight years, all children produce all the sounds correctly.

In western countries, the norms clinicians use are mostly based on the studies of several authors. Table 2 depicts the acquisition of speech sounds given by various authors.
Table 2: Age levels (Years-Months) for speech sound development according to six studies

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<td>Before 2</td>
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<tr>
<td>n</td>
<td>3</td>
<td>4 ½</td>
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<td>Before 2</td>
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<td>h</td>
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<td>Before 2</td>
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<td>p</td>
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<td>f</td>
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<td>5 ½</td>
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<td>3 ½</td>
<td>3</td>
<td>Before 2</td>
<td>2-8</td>
<td>3</td>
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<tr>
<td>b</td>
<td>3</td>
<td>3 ½</td>
<td>Before 2</td>
<td>2-8</td>
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<td>η</td>
<td>4</td>
<td>4 ½</td>
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<td>j</td>
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<td>7 ½</td>
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<td>3</td>
<td>4</td>
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<tr>
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<td>7 ½</td>
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<td>3-4</td>
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<td>tf</td>
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<td>4 ½</td>
<td>4</td>
<td>3-8</td>
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<tr>
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<td>5</td>
<td>6 ½</td>
<td>6</td>
<td>4</td>
<td>4</td>
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<td>7 ½</td>
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<td>6 ½</td>
<td>7</td>
<td>6</td>
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<td></td>
</tr>
<tr>
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<td>6 ½</td>
<td>4 ½</td>
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<td>3-8</td>
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<tr>
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<td>5</td>
<td>4</td>
<td>5</td>
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</tbody>
</table>

Norms are useful only as broad guidelines. Studies have shown that individual children vary tremendously in their articulatory skills. Some children produce most speech sounds correctly by the age of 2 or 3 years. Others continue to master various sounds even at the age of 6 or 7 years. Table 3 shows the age at which consonants usually produced and consonants usually mastered given by Stoel-Gammon and Dunn (1985).
Table 3: Age of customary production and mastery of consonant phonemes

<table>
<thead>
<tr>
<th>Age</th>
<th>Consonants customarily produced</th>
<th>Consonants mastered</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>t, d, k, g, n</td>
<td>p, m, n, w, h</td>
</tr>
<tr>
<td>3.0</td>
<td>f, s, r, l, j</td>
<td>p, m, n, w, h</td>
</tr>
<tr>
<td>4.0</td>
<td>v, z, [l, t, l, d</td>
<td>b, d, k, g, f, j</td>
</tr>
<tr>
<td>5.0</td>
<td>θ, ɕ</td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td></td>
<td>t, η, r, l</td>
</tr>
<tr>
<td>7.0</td>
<td></td>
<td>θ, [l, t, l, d</td>
</tr>
<tr>
<td>8.0</td>
<td></td>
<td>v, ɕ, s, z</td>
</tr>
</tbody>
</table>

Consonant clusters which is the combination of two or more consonants in the initial or final position is generally a late development in the phonological system. In general, two member clusters are acquired earlier than three member clusters. Table 4, shows the age of mastery of consonantal clusters given by Stoel-Gammon and Dunn (1985).

Table 4: Age of mastery of consonantal clusters

<table>
<thead>
<tr>
<th>Age</th>
<th>Initial clusters</th>
<th>Final clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>pl, bl, kl, gl, pr, br, tr, dr, kr tw, kw sm, sn, sp, st, sk</td>
<td>mp, mpt, mps, ηk lp, lt, rm, rt, rk pt, ks ft</td>
</tr>
<tr>
<td>5.0</td>
<td>gr, fl, fr, str</td>
<td>lb, lf, rd, rf, rm</td>
</tr>
<tr>
<td>6.0</td>
<td>skw</td>
<td>lk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rb, rg, rθ, rdʒ, rst, rt nt, nd, nθ</td>
</tr>
<tr>
<td>7.0</td>
<td>spl, spr, skr sl, sw θr, fr</td>
<td>sk, st, kst lθ, lz dʒd</td>
</tr>
<tr>
<td>8.0</td>
<td></td>
<td>kt, sp</td>
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</tbody>
</table>
In India, many studies have been carried out on speech and language acquisition. Table 5 shows the age of acquisition of various speech sounds in different Indian languages.

Table 5: Age levels (Years-Months) for speech sound development in Indian studies

<table>
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<td>2.6</td>
<td>3</td>
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<td>p</td>
<td>3</td>
<td>3</td>
<td>2.6</td>
<td>2.5</td>
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<tr>
<td>f</td>
<td>+</td>
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<td>2.9</td>
<td>+</td>
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<tr>
<td>b</td>
<td>3</td>
<td>3</td>
<td>2.6</td>
<td>2.5</td>
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<td>+</td>
<td>+</td>
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<tr>
<td>y</td>
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<td>3</td>
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<td>3</td>
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<td>+</td>
<td>+</td>
<td>3</td>
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<td>s</td>
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<td>3.3</td>
<td>+</td>
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<tr>
<td>r</td>
<td>4.6</td>
<td>+</td>
<td>3.9</td>
<td>4</td>
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<tr>
<td>c</td>
<td>3.7</td>
<td>3</td>
<td>2.6</td>
<td>3</td>
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<tr>
<td>v</td>
<td>+</td>
<td>3</td>
<td>2.6</td>
<td>+</td>
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<tr>
<td>ñ</td>
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</table>

Note: ‘+’ means sound was not tested or reported

Patterns of acquisition

In recent years, the attention has shifted from the acquisition of single phonemes to the acquisition of sound patterns and processes underlying such patterns. Traditional analysis of speech sound development in children has treated phonemes as separate, individual entities in terms of acquisition. However, Ingram (1981) revealed
that this was not necessarily a correct approach and there seems to be very general simplifying processes, which are in operation during children’s incorrect productions that affect entire classes of speech sounds, rather than one particular phoneme. In other words, children are not haphazard in their mispronunciation of words, but they are in fact quite systematic. Therefore in the past two to three decades a new way of describing sound production errors has become increasingly popular. Rather than focusing on individual phonemes, many recent researchers have shifted their attention to analyzing sound production according to phonological processes. One fact about phonological development on which linguists agree is the systematic nature of the child’s simplifications and restructuring of adult words (Macken and Ferguson, 1981) (Cited in Bernthal & Bankson, 1993).

Phonological processes

The term ‘phonological process’ is most frequently used to describe the patterned modification of the adult model by normally developing children. In other words, the child simplifies the complex adult model by substituting sounds that are within his or her phonetic repertoire for those sounds that he or she has not yet acquired.

As Oller (1975) (Cited in Bernthal & Bankson, 1993) explicitly puts it, “the sorts of substitutions, deletions and additions which occur in child language are not merely random errors on the child’s part, but are rather the result of a set of systematic tendencies”. For example, when a 3-year-old produces a series of words like [tænt] for can’t, [tɔz] for cause and [ta ] for cow, the linguist formulates a rule to express the
observed regularity: $[k] \rightarrow [t]$, which means /k/ is substituted by /t/; in this case no “conditioning environment” or context is given since the substitution appears to occur in a wide range of contexts. The child also says [det] for get, [do] for go and [di:n] for green, the rule can be expressed more generally as “a velar stop is realized as a dental (or alveolar) stop.”

Phonological substitutions typically show great regularity in the language of children past the earliest stage of lexical acquisition. Linguists express that regularity by using phonological rules, or what have come to be known the child language literature as “phonological processes”. The processes are used to some extent by virtually all children in the earlier stages of word acquisition, but a given child will quickly master certain difficulties (Ex:, the production of velars or fricatives or closed syllables, depending on his or her phonetic preferences and the words he or she has been attempting) and thereby obviate the need for the corresponding processes (velar fronting, stopping, final consonant deletion).

Lowe (1996) (Cited in Hegde, 2000) defines a phonological process as “systematic sound change that affects classes of sounds or sound sequences and results in a simplification of productions”. For example, a three-year-old child who has not yet acquired many fricative sounds may often substitute stops for these sounds, a phonological process known as ‘stopping’ occurs. In normal phonological development, these processes naturally occur and the child overcomes these to produce exact phonemes. When this overcoming does not occur, leading to phonological disorder, then the processes are pathological. Stampe (1969), Donegan
and Stampe (1979) (Cited in Grunwell, 1997) describe that phonological processes are innate simplification tendencies. Grunwell (1997) (Cited in Hegde, 2000) states that the concept of phonological process in the clinical assessment of child speech is applied primarily as a descriptive device that analyses systematic patterns in children’s pronunciation by comparison with the target adult pronunciations. During the developmental period, children’s production errors can be reliably classified according to various patterns of phonological processes. Ingram (1981) classified the simplifying processes into three main categories: Syllable structure processes, Substitution processes and Assimilatory processes. The phonological processes described by various authors are summarized here.

I. **Syllable structure processes**

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

1. **Unstressed syllable deletion**

Unstressed-syllable deletion (USD) describes the omission of one or more syllables from a polysyllabic word. As the name implies, the syllable with the least stress is typically the one deleted. However, deletion of stressed syllables can also occur. This process is also called weak-syllable deletion and syllable deletion. This process seldom occurs in normal children after age three.

   Ex: potato [teto]          telephone [tɛfon]
2. **Reduplication**

Reduplication is the repetition of a syllable of a target word. This repetition results in the creation of a multisyllabic word form. Because of the duplicating nature of this process, it is sometimes called doubling. Reduplication may be total or partial. Total reduplication occurs when the entire syllable is repeated. Partial reduplication occurs when only part of the entire syllable is repeated. Ingram (1989) described reduplication as an early process of acquisition associated with the first 50 words. Lleo (1990) reports that reduplication may disappear after the 50 word stage but reappear when child begins production of trisyllables at or about 3 years of age. Stoel-Gammon and Dunn (1985) (Cited in Hegde, 2000) indicate that reduplication is often accompanied by final-consonant deletion in productions such as [kækæ] for *cat*, in which the final /t/ is deleted first and then the syllable /kæ/ is totally reduplicated.

Ex:  
- bottle [baba] (total)  
- bottle [bada] (partial)  
- dog [dada] (total)  
- dog [dadi] (partial)

3. **Diminutization**

Diminutization is the addition of /i/ or sometimes [Ci] (C = consonant) to the target word. Lowe (1996) (Cited in Hegde, 2000) describes diminutization as a special form of partial reduplication.

Ex:  
- pencil [papi]  
- doll [dali]

4. **Epenthesis**

Epenthesis can be characterized by the insertion of an unstressed vowel, usually the schwa /ə/, between two consonants. Typically the vowel is inserted
between two contiguous consonants that make up an initial cluster as in [bɛlu] for blue (Stoel Gammon & Dunn, 1985) (Cited in Hegde, 2000). These scholars indicate that epenthesis can also occur when an unstressed vowel is added after a final voiced stop. Khan (1985) notes the insertion of a vowel between two consonants functions to simplify the cluster but does not include the processes under cluster reduction as all members of the cluster are retained.

Ex: spoon [səpun] cup [kʌpə]

5. Initial consonant deletion

Initial-consonant deletion (ICD) or the omission of singleton consonants in the initial word position is not a naturally occurring process, meaning that it is rare in normal phonological development. Khan and Lewis (1986) also consider omission of the entire initial cluster as an example of ICD. Thus [ek] for break would be considered an example of both total cluster reduction and initial consonant deletion since all members of the cluster are deleted.

Ex: phone [ən] shoe [u]

6. Final consonant deletion

Final consonant deletion (FCD) is characterized by the omission of a final singleton consonant in a word. Final consonant deletion is common in children between the age of 1.6 and 3.0 but rare beyond 3 years of age (Ingram, 1989).

Stoel-Gammon and Dunn (1985) and Khan and Lewis (1986) also consider the deletion of all members of a final consonant cluster as part of FCD. It is important to
note that the entire cluster must be deleted for this type of error to fall under the category of FCD.

Ex: Fish [fi] books [bu]

7. Cluster reduction

Cluster reduction (CR) may be defined as the deletion or substitution of some or all members of a cluster. When all members of a cluster are deleted, it is considered total-cluster reduction (TCR), whereas omission of only some of the members of a cluster is regarded as partial-cluster reduction (PCR).

<table>
<thead>
<tr>
<th>Total-cluster reduction</th>
<th>Partial-cluster reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex: palm [pa]</td>
<td>palm [pam]</td>
</tr>
<tr>
<td>dark [da]</td>
<td>dark [dak]</td>
</tr>
</tbody>
</table>

Cluster substitution, on the other hand, is the substitution of one or all members of a cluster by another sound. Cluster substitution most often affects clusters that contain a liquid (Lowe, 1996) (Cited in Hegde, 2000). Stoel-Gammon and Dunn (1985) describe a pattern by which all the members of the cluster are replaced by a sound that was not a member of the target cluster.

Ex: frog [pag] stove [bov]

Stoel-Gammon and Dunn (1985) describe some of the most common reduction patterns as follows:

- Children attempting to produce a /stop+liquid/ cluster will typically delete the liquid

Ex: green [gin] bread [bed]
• Children attempting to produce a /liquid + stop/ or /liquid + nasal/ postvocalic cluster usually delete the liquid

   Ex: park [pak]               born [bon]

• Children attempting an /s + stop/ or /s+ nasal/ cluster will typically delete the /s/

   Ex: stove [tov]               sneeze [niz]

8. Coalescence

Coalescence is a process in which segments that are present in two syllables are combined into one.

   Ex: pacifier /pæf/, where /p/ is retained from the first syllable and the /f/ from the third syllable.

Hodson (1980) has a slightly different description of coalescence in that he used the term for the use of one consonant, which combines the features of the two consonants of a cluster.

   Ex: smoke /fɔk/, in which /f/ has the stridency /s/ and labialness of /m/

   plane /ten/, in which the /t/ has alveolar placement of the /l/ and the stop manner of the /p/.

II. Substitution processes

These are the processes in which one class of sounds is substituted for another class of sounds with the replacement sound reflecting changes in place of articulation, manner of articulation or some other change in the way a sound is produced in a
standard production. Weiner (1979) labeled these processes as feature contrast processes. The processes based on the features are as follows:

1. Place changes

   i. Fronting – Fronting (Fr) refers to the replacement of a target phoneme with another phoneme which is articulated or produced anteriorly to the target. Two forms of fronting reported in the western literature are velar and palatal. Retroflex fronting has been reported in an Indian study.

   **Velar fronting** is the replacement of the velars /k/,/g/,/ŋ/ with sounds that are made in a more anterior position. The more common substitutions are [t for k], [d for g], and [n for ŋ]; however other substitutions can occur (ex: [d for k], [k for ŋ]). Stoel-Gammon and Dunn (1985) (Cited in Hegde, 2000) indicate that velar fronting occurs more commonly in word-initial than word-final position.

   Ex: cow [tau] key [ti]

   **Palatal fronting** (sometimes called depalatalization) is the replacement of a palatal by a sound made further forward in the mouth. Lowe, Knutson and Monson (1986) screened 1048 children between the ages of 31 and 54 months for the presence of fronting. They observed fronting in 6% of the pre-schoolers with velar fronting occurring more frequently than palatal fronting which rarely occurred after the age of 42 months. Stoel-Gammon and Dunn (1985) stipulate that depalatalization is the substitution of an alveolar fricative for a palatal fricative or alveolar affricate for a

Ex: Jane [den] check [tɛk]

Retroflex fronting is the replacement of a retroflex by a sound made further forward in the mouth. Retroflexes are usually fronted to alveolars and dentals. Fronting of retroflexes was identified in a study, which was carried out on Kannada speaking normal and hard of hearing children (Ramadevi & Prema, 2002).

Ex: kavu [kannu] aļu [alilu]

ii. Backing - Although backing is not a commonly occurring phonological process in normal development, it may be observed in children with severe phonological disorders. Sounds with an anterior point of constriction are replaced by posterior sounds. This process typically affects alveolar and palatal consonants.

Ex: top [kap] soap [hop]

2. Manner changes

i. Liquid gliding is defined as the substitution of a glide for a prevocalic liquid. This process affects manner of articulation. The liquids /r/ and /l/ are typically replaced by the glides /w/ and /j/, respectively. Gliding is most commonly seen in 3 and 3.5 year old children. Hodson and Paden (1981) list it as one of the most common processes observed in the speech of unintelligible children.

Ex: look [wuk] ring [wing] green [gwin]
ii. **Fricative gliding** is another form of gliding (Lowe, 1996) (Cited in Hegde, 2000). In fricative gliding, a fricative is replaced by a liquid or a glide. Fricative gliding does not occur as frequently as liquid gliding. Weiner (1979) reported that gliding of fricative occurs primarily in children with deviant phonology.

Ex: shoe [ju] soap [lop]

iii. **Stopping** is most frequently defined as the substitution of stops for fricatives and affricates. Some definitions are very inclusive, stating that stopping can affect fricatives, affricates, liquids, and glides (Lowe, 1996) (Cited in Hegde, 2000). Stopping of fricatives is common in normal phonological development. Although stopping can occur in all word positions, it is often observed in word-initial position.

Ex: sop [top] job [dob]

iv. **Deaffrication** refers to the replacement of an affricate with a stop or fricative. Robert, Burchinal and Footo (1990) indicate that deaffrication occurs more frequently than some common processes. Deaffrication is usually suppressed prior to 4 years. Lowe (1996) (Cited in Hegde, 2000) considers any sound change that results in a nonaffricate as deaffrication.

Ex: chair [ter] chop [sap]

v. **Affrication** refers to the replacement of a fricative by an affricate. Hodson (1980) reported that children seem to use this process when they are developing continuous sounds and are learning to differentiate between stops and continuants.

Ex: saw [tʃau] shoe [tʃu]
**vi. Vocalization** is also called vowelization. It is the substitution of a vowel for a syllabic liquid (Stoel-Gammon & Dunn, 1985). Lowe (1996) (Cited in Hegde, 2000) indicates that this process can also affect syllabic nasals. When the mid-central vowels /ɔ/ and /ʌ/ are replaced by /ə/ or any other vowel, this is also considered vocalization.

Ex: simple [simpo] paper [pepo]

Stoel-Gammon and Dunn (1985) and Hodson and Paden (1983) indicate that vocalization can also affect post-vocalic liquids. The substitution of a vowel for post-vocalic liquids is most often categorized under vocalization rather than final consonant deletion.

Ex: bowl [bo] car [ka]

**vii. Stridency deletion** is closely associated with stopping. This process occurs when a strident sound (f, v, s, z, [ʃ], [ʒ], dz) is either deleted or replaced with a non strident sound. Stridency deletion typically occurs through stopping, though it is possible for stopping to occur without stridency deletion. Both stopping and stridency deletion are very common in the speech pattern of phonologically disordered children (Hegde, 2000). Hodson and Paden (1983) noted that the most unintelligible children omit the strident sound while children with severe phonological problem use non strident substitutes.

Ex: soap /op/ or /top/

**viii. Palatalization** occurs when a sound is produced as a palatal rather than as a non-palatal. Hodson (1980) reported that this process occurs on sibilants and cluster.

Ex: soup [ʃup] cream [ʃim]
ix. Neutralization occurs when several different phonemes are replaced by one sound. This process may appear on both vowels and consonants. One cannot predict which consonant will replace a particular group of sounds. Different speakers show different preferences.

Ex: A child who replaced all pre-vocalic fricatives and affricates with /j/ such that sun was pronounced as [jʌn] and juice as [ju].

III. Assimilation Processes

Assimilation refers to the phenomenon by which one sound changes to become more like another sound, particularly its neighboring sounds. The term consonant harmony is sometimes used in reference to assimilation processes that affect manner of production or place of articulation. Vihman (1978) comments that consonant harmony is common in child phonology. Grunwell (1987) notes that assimilation process causes a structural simplification.

Assimilation can also be classified, as progressive and regressive depending where the sound that changes is located in relation to the sound that causes the change. If the sound that changes precedes the sound that causes the change, the modification is categorized as regressive or anticipatory assimilation. If the sound that changes follows the sound that influences the change, the modification is considered progressive assimilation. Regressive assimilation is the production [tot] for coat; and [bib] for bean is an example of progressive assimilation because the sound that changed /n/, followed the sound that created the change.
Assimilation can be total or partial. In total assimilation a sound that changes becomes identical to the sound that causes the change, while in partial assimilation the changed sound takes on only some of the characteristics of the sound effecting the change.

<table>
<thead>
<tr>
<th>Total Assimilation</th>
<th>Partial Assimilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>cup [kʌk]</td>
<td>cup [kʌg]</td>
</tr>
<tr>
<td>mop [mɑm]</td>
<td>mop [mɑn]</td>
</tr>
</tbody>
</table>

Assimilation has also been described as contiguous and noncontiguous. If the sound that changes and the sound that influences the change are adjacent to each other, with no interfering sound between them, this is contiguous assimilation. However, if the changed sound and the sound that effects the change are separated by an intervening sound, the term noncontiguous assimilation applies. The process of assimilation can affect a sound’s manner of production, place of articulation, and voicing features. The assimilation processes are as follows:

1. **Labial assimilation**

   It is the process by which a non-labial consonant becomes a labial because of the influence of another labial sound in a word. Stoel-Gammon and Dunn (1985) indicate that in most cases labial assimilation affects alveolar and palatal sounds; however, any non-labial sound can be affected.

   Ex: moss [mɑb] pen [pɛb]
2. **Velar assimilation**

It is characterized by assimilation of a non-velar sound to velar sound. Velar assimilation typically affects alveolar and palatal consonants. The velars that can influence the change are /k/, /g/ and /ŋ/.

Ex: keep [kik]  goat [gog]

3. **Alveolar assimilation**

It is characterized by assimilation of a non-alveoral sound to an alveolar sound.

Ex: soup [sut]  lip [lid]

4. **Nasal assimilation**

It is the process by which a non-nasal sound assimilates to become a nasal because of the influence of another nasal in the word. Weiner (1979) mentioned that other types of manner assimilation also occur including stop assimilation and fricative assimilation.

Ex: nose [non]  mike [maim]

5. **Voicing assimilation**

It has two common types. These are as follows:

i. **Prevocalic voicing** refers to voicing of the vowel influencing the voicing feature of the preceding consonant. Ingram (1981) describes this process as the changes of voiceless obstruent (fricative, affricate or stop) into a voiced one when preceding a vowel within the same syllable.

Ex: suit [zut]  pie [bai]
**ii. Postvocalic devoicing** is a process by which a voiced obstruent following a vowel (postvocalic) becomes voiceless or devoiced.

Ex: pig [pik] \> bees [bis]

All these phonological processes are found in the normal child language acquisition and not all of them in a particular child. As the child acquires more and more phonological skills, these processes gradually disappear.

**Chronology of processes**

The simplification processes described do not disappear in child's speech at the same time. Different processes have varying permanence in developing phonologies. Stoel-Gammon and Dunn (1985) divided processes into two categories which are shown in the Table 6.

<table>
<thead>
<tr>
<th>Processes disappearing by 3 years</th>
<th>Processes persisting after 3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unstressed syllable deletion</td>
<td>Cluster reduction</td>
</tr>
<tr>
<td>Final consonant deletion</td>
<td>Epenthesis</td>
</tr>
<tr>
<td>Velar fronting</td>
<td>Gliding</td>
</tr>
<tr>
<td>Consonant harmony</td>
<td>Vocalization</td>
</tr>
<tr>
<td>Reduplication</td>
<td>Stopping</td>
</tr>
<tr>
<td>Prevocalic voicing</td>
<td>Depalatalization</td>
</tr>
<tr>
<td></td>
<td>Final devoicing</td>
</tr>
</tbody>
</table>

Grunwell (1981) (Cited in Grunwell, 1997) presented a chronology of phonological processes which is shown in Table 7.
Table 7: Chronology of phonological processes

<table>
<thead>
<tr>
<th>Process</th>
<th>2.0-2.6</th>
<th>2.6-3.0</th>
<th>3.0-3.6</th>
<th>3.6-4.0</th>
<th>4.0-4.6</th>
<th>4.6-5.0</th>
<th>5.0 →</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak Syllable Deletion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• • •</td>
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<tr>
<td>Final Consonant Deletion</td>
<td></td>
<td></td>
<td>• • •</td>
<td></td>
<td></td>
<td></td>
<td>• • •</td>
</tr>
<tr>
<td>Reduplication</td>
<td></td>
<td></td>
<td>• • •</td>
<td>• • •</td>
<td></td>
<td></td>
<td>• • •</td>
</tr>
<tr>
<td>Consonant Harmony</td>
<td></td>
<td></td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
<td></td>
<td>• • •</td>
</tr>
<tr>
<td>Cluster Reduction (initial) obstruent + approximant /s/ + consonant</td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
</tr>
<tr>
<td>Stopping</td>
<td>/f/</td>
<td>/v/</td>
<td>/θ/</td>
<td>/ð/</td>
<td>/s/</td>
<td>/z/</td>
<td>/t/</td>
</tr>
<tr>
<td>Fronting</td>
<td>/k, g, p/</td>
<td>/r/ → [w]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gliding /r/ → [w]</td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
<td></td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
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<tr>
<td>Context-sensitive Voicing</td>
<td></td>
<td></td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
<td>• • •</td>
</tr>
</tbody>
</table>

Note: The solid black line across an age band indicates that almost all children at this age will demonstrate use of the process. A broken line indicates that at that age, an appreciable number of children will not be using the process or will be using it variably.

According to Tables 6 and 7, the processes, final consonant deletion, consonant harmony, reduplication, velar fronting and prevocalic voicing disappear by
the age of three years whereas the processes, cluster reduction, stopping of certain consonants persists even after three years. However, both the studies differ regarding the age of disappearance of unstressed syllable deletion process. The age of suppression of various processes as reported by Smit (1993) (Cited in Bauman-Waengler, 2004) and Lowe (1996) (Cited in Hegde, 2000) are presented in Table 8. According to these scholars, denasalization is the first process to be suppressed whereas Epenthesis and cluster reduction are last ones to disappear.

Table 8: Age of suppression for several processes

<table>
<thead>
<tr>
<th>Process</th>
<th>2.0</th>
<th>3.0</th>
<th>4.0</th>
<th>5.0</th>
<th>6.0</th>
<th>7.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labialization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alveolarization</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Affrication</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Deaffrication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vowelization</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Derhotacization</td>
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<td></td>
</tr>
<tr>
<td>Denasalization</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Epenthesis</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cluster reduction</td>
<td></td>
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</tr>
</tbody>
</table>
**Co-occurrence of processes**

Often children's production contain more than one process. When the words have more than one simplification process, there might be cases in which we have to assume a particular ordering of the processes is in effect. The processes occurring in

Ex: speak [bi] - are Final consonant deletion, Cluster reduction, Prevocalic voicing.

cherry [dëwi] – are Fronting, Stopping, Prevocalic voicing, Liquid gliding.

**Between word processes**

Adult phonologies generally involve both within word and between-word processes. American English contains a number of between-word processes. For example, a word-final /t/ in a word such as *white* generally becomes an alveolar flap when the next word begins with a vowel, as in *white elephant*. A word final /s/ often becomes a palato alveolar fricative if the next word begins with the glide /j/, as in *kiss you*. Between word processes occur in child phonology.

Stemberger (1988) in a dairy study of his first daughter, Gwendolyn, he observed a number of a processes. It was a dairy study of the acquisition of American English in monolingual speech situation. The processes found were Word-final resyllabification, H- Fusion, /l/ doubling, Vowel deletion, Word final nasal assimilation, Word initial /ð/ deletion, Closed class reduplication and Labiodental harmony. The eight between-word processes in Gwendolyn’s speech resembled
processes found in adult phonology. While most child phonology process may be restricted to apply within words, some processes do involve more than one word. According to Stemberger (1987), reduplication and consonant harmony are common between-word processes.

**Idiosyncratic processes / Unusual processes**

Processes that never occur or occur only rarely in normal phonology are called unusual or idiosyncratic processes (Stoel-Gammon and Dunn 1985). Individual children sometimes use processes which are unique to their phonological system. Leonard (1985) defined unusual phonological processes that had been previously identified in the speech of the children with phonological disorders who did not have identifiable physical, physiological or auditory deficiencies. He identified three categories of phonological behavior:

1. Salient but unusual sound change with readily detectable systematicity.

   These are atypical substitution patterns such as:

   • Early sounds replaced by late sounds.
   • Additions to adult forms
   • Use of sounds absent from the model language
   • Use of sounds absent from natural language

2. Salient but unusual sound change with less readily detectable systematicity.

   These are patterns such as:

   • Assimilations, both reduplications and consonant harmony
   • Metathesis
• Syllable structure deletion such as posttonic weak syllable deletion and within word consonant deletion.

3. The third category deals with phonetic phenomena that are imperceptible to adult listeners but are revealed by the acoustic analysis.

Grunwell (1985) (Cited in Grunwell, 1997) put forth a framework for the developmental diagnosis, which is based on the chronology of phonological processes. The framework has led to the identification of three potential developmental differences:

• Delayed
• Uneven
• Deviant

Phonological process analysis provides five characteristics of disordered phonological development (Grunwell, 1981,1985, 1987,1988; Stoel-Gammon & Dunn, 1985) (Cited in Grunwell, 1997), which serve as diagnostic indicators. These are as follows:

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 expected to have been “suppressed” such as fronting of velars present in the speech of a child of 3.6-3.9. This indicates whether the child’s phonological development is delayed to a greater or lesser extent.

2. **Chronological mismatch** is the co-occurrence of some of the earliest normal simplifying processes with some patterns of pronunciation characteristic of later stages in phonological development, such as fronting of velars and the development of word initial cluster present in the speech of a child aged 3.6 – 3.9. Such uneven progress is suggestive of disrupted or literally “dis-ordered” development.

3. **Unusual processes** are simplifying patterns that have been rarely attested in normal speech development of that appear to be different from normal developmental processes and may, therefore, be idiosyncratic. As indicated above, this definition is carefully constructed so as not to exclude the possibility that a child who subsequently exhibits normal developmental achievements might display apparently unusual patterns for a short period of time.

4. **Variable use of processes** occurs when more than one simplifying process routinely operates with the same target type of structure, so that the child’s realizations are variable and unpredictable: pie (bat) pour (po). This variability is potentially progressive in that it entails the possible development of target contrast. Variability is abnormal when it is not potentially progressive:

   Ex: rake (lēlk), rabbit (ablīt), ring (wInē), red (oēd)
5. **Systematic sound preference** occurs when one type of consonant is used for a large range of different target types. For example:

- Fronting of /k/
- Fronting of /g/
- Stopping and voicing of /θ, s, ʃ, tʃ/ 
- Stopping of /ð z ʒ ʒə/ 
- Voicing of /v/

Cluster reduction involving these targets, the co-occurrence of all these processes thus results in systematic sound preference for [d].

Various unusual processes described by various authors are listed in Table 9.

**Table 9: Unusual phonological processes described by various authors**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Phonological process</th>
<th>Scholar</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Apicalization</td>
<td>Roberts, Burchinal and Footo (1990)</td>
<td>A labial is replaced by an apical consonant</td>
<td>Ex: bow [do]</td>
</tr>
<tr>
<td>2</td>
<td>Articulatory shifts</td>
<td>Hodson (1980)</td>
<td>There are minimal shifts in place of articulation while the manner of articulation generally remains the same</td>
<td>Ex: think [fink] mouth [mðus]</td>
</tr>
<tr>
<td></td>
<td>First type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Second type - Frontal lisp</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Third type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fourth type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>It is the substitution of /f, ɹ, s, ʃ, z, tʃ, ʒ, ʒə/ for /θ, d/</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Producing /s/ and /z/ and sometimes /ʃ, z, tʃ, ʒə/ with a protruded tongue</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dentalization of /t, d, n, l/ with protruded tongue.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lateralization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Atypical cluster reduction</td>
<td>Stoel-Gammon and Dunn (1985)</td>
<td>Deletion of the member that is usually retained</td>
<td>Ex: play [le] stop[sɔp]</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>4</td>
<td>Backing of fricatives</td>
<td>Dodd (1989)</td>
<td>Replacement of fricatives with fricatives</td>
<td>Ex: suit [jut]</td>
</tr>
<tr>
<td>5</td>
<td>Backing of stops</td>
<td>Dodd (1989)</td>
<td>Replacement of front consonants by phonemes made posterior to the target phonemes</td>
<td>Ex: toe [ko]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Weiner (1979)</td>
<td>More frequent in the word initial and medial position than in the word final position</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Devoicing of stops</td>
<td>Dodd (1989)</td>
<td>Replacement of voiced stop with a voiceless phoneme</td>
<td>Ex: daddy [tæ di]</td>
</tr>
<tr>
<td>8</td>
<td>Fricative replacing stops</td>
<td>Stoel-Gammon and Dunn (1985)</td>
<td>Substitution of a fricative consonant for a stop consonant</td>
<td>Ex: bat [bæs]</td>
</tr>
<tr>
<td>9</td>
<td>Glottal replacement</td>
<td>Stoel-Gammon and Dunn (1985)</td>
<td>Substitution of a glottal stop for a consonant usually in medial or final position</td>
<td>Ex: fishing [fi?m] tooth [tu?]</td>
</tr>
<tr>
<td>10</td>
<td>Initial consonant deletion</td>
<td>Dodd (1989)</td>
<td>Deletion of word initial consonant or cluster</td>
<td>Ex: tape [ep] star[ɔr]</td>
</tr>
<tr>
<td>11</td>
<td>Medial consonant deletion</td>
<td>Dodd (1989)</td>
<td>Deletion of intervocalic consonants</td>
<td>Ex: beetle [bio]</td>
</tr>
<tr>
<td>12</td>
<td>Medial consonant substitution</td>
<td>Dodd (1989)</td>
<td>Replacement of intervocalic consonants with one or more phonemes</td>
<td>Ex: butter [bʌʃə]</td>
</tr>
</tbody>
</table>
These phonological processes are regarded as idiosyncratic or less common processes. Most of the studies have been carried on processes affecting consonants and a few studies have been done on processes affecting vowels.

**Vowel patterns in child phonology**

Although the emphasis of research on phonological developments and disorders has been on consonants, some recent studies have focused on the development of the vowel system (Pollack and Keiser, 1990; Stoel-Gammon and Herrington, 1990; Reynolds, 1990). Linguists have long been aware of processes that affect vowels. Schane (1973) describes vowel epenthesis, vowel deletion, vowel harmony, vowel coalescence, vowel shift and vowel neutralization. Reynolds (1990) identified the following patterns in vowel disorders:

1. Lowering of mid front vowels: /ɛ/ to /a/
2. Fronting of low back vowels to /a/
3. Diphthong reduction to monophthong /ei/ to /a/

Pollack and Keiser (1990) evaluated 15 phonologically disordered children for the presence of vowel errors. They posited that the errors would fall into one of the three sub types:

- Feature changes, in which vowel features (height, frontness, roundness) changes its value.
- Complexity changes, which involves changes in diphthongal nature of vowels.
- Vowel harmony, in which a vowel changes to become more like another vowel in the same word.

They noted most errors were feature changes followed by complexity changes. Harmony processes were rare. Several authors have described different vowel processes which is illustrated in Table 10.
Table 10: Vowel processes described by various authors

<table>
<thead>
<tr>
<th>Types</th>
<th>Vowel process</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feature changing processes</td>
<td>Vowel backing</td>
<td>A vowel being replaced with a more posterior vowel</td>
<td>Ex: /æ/ → /a/</td>
</tr>
<tr>
<td></td>
<td>Vowel Lowering</td>
<td>A vowel is replaced with vowel made with a lower tongue height</td>
<td>Ex: /I/ → /e/</td>
</tr>
<tr>
<td></td>
<td>Centralization</td>
<td>Replacement of a vowel with a central vowel typically the schwa or stressed form</td>
<td>Ex: /e/ → /ʌ/</td>
</tr>
<tr>
<td></td>
<td>Vowel Unrounding</td>
<td>Normally rounded vowel is produced without the rounding</td>
<td>Ex: /ɔ/ → /a/</td>
</tr>
<tr>
<td></td>
<td>Vowel fronting, raising, tensing and laxing.</td>
<td>Occur rarely</td>
<td>Pollack and Keiser (1990)</td>
</tr>
<tr>
<td>Complexity Changes</td>
<td>Diphthongization</td>
<td>Monophthong vowel is produced as a diphthong</td>
<td>Ex: /a/ → /æ/</td>
</tr>
<tr>
<td></td>
<td>Diphthong Reduction</td>
<td>A diphthong is reduced to a monophthong</td>
<td>Ex: /æ/ → /a/</td>
</tr>
<tr>
<td>Vowel Harmony</td>
<td>Complete Vowel Harmony</td>
<td>One vowel is changed so that both vowels in the word are the same</td>
<td>Ex: /ɔfis/ → /ɔfɔs/</td>
</tr>
<tr>
<td></td>
<td>Height vowel harmony</td>
<td>Vowel is replaced with a vowel that is closer in production to the height of another vowel in the same word</td>
<td>Ex: /himæn/ → /himIn/</td>
</tr>
<tr>
<td></td>
<td>Tenseness Harmony</td>
<td>Lax vowel becoming tense when there is another tense vowel in the same word</td>
<td>Ex: /kuki/ → /kuki/</td>
</tr>
</tbody>
</table>

Thus we see a number of phonological processes which occur in many children. Many studies have focused on normal child phonology which are described here.
Phonological processes in normal children

Many scholars have demonstrated that the verbal child’s sound system (either normal or abnormal) can be described as a set of systematic correspondences between standard adult and child phonological forms. They described the correspondences as a set of substitution processes, which account for the relationship between the child’s phonological forms and the adult forms the child attempts to produce.

According to Ingram (1976) the common phonological processes include fronting, reduplication, syllable deletion/reduction, assimilation, stopping, liquid gliding and cluster reduction. Reduplication and homonymy and have been proposed for the earliest stages of linguistic development throughout the recent literature on phonological acquisition.

Haelsig and Madison (1986) studied developmental data on the phonological processes of fifty English speaking normal children, ranging in age from 2:10 to 5:2 years. The Phonological process Analysis (PPA, Weiner, 1979) was administered to all subjects. The processes of cluster reduction, weak syllable deletion, glottal replacement, labial assimilation and gliding of liquids were used by 3-and 3 ½-year-old children. Weak syllable deletion and cluster reduction was prominent in the speech of 4 ½ and 5-year-old children. These processes indicated a delayed or disordered phonological system. This study found that greatest reduction in use of the phonological processes occurred between 3 and 4 years of age. Deletion of final consonants, stopping, fronting and gliding of liquids were processes whose frequency was reduced by 50% in the 4-year-old subjects.
Lleo (1990) carried out a longitudinal study. Lleo’s first daughter, Laura, grew up trilingually as she acquired German from the country where she was born, Catalan from her mother, and Spanish from her father. The data was collected in the diary style, supplemented by regular sound-recordings. In this case study, homonymy started to decrease when the number of syllables of the word increased, as trisyllables entered the lexicon in large quantities. But at the same time the pronunciation of trisyllables was made possible through the repetition of syllables within a single word, i.e. through reduplication.

Roberts, Burchinal and Footo (1990) studied the occurrence of phonological processes in 145 normal children who were between the ages of 2 ½ and 8 years. The results suggest that children’s use of common phonological processes show the most dramatic decline between the ages of 2 ½ and 4 years. The most commonly occurring processes during this time are deletion of final consonants, cluster reduction, fronting, stopping and liquid gliding. After age 4, cluster reduction and liquid gliding are used less frequently, and deletion of final consonants, fronting, and stopping occur rarely. There is also much less change in process usage between the ages of 4 and 8 years. These developmental patterns are consistent with the findings of Grunwell (1981), Healsig and Madison (1986) (Cited in Roberts, et al., 1990). By age 8, few common phonological processes of any type were found to occur.

All these studies suggested that there was a major change in process usage prior to age 4 and little change after that age. It is essential to know whether the
Phonological processes seen in normal children are found in other clinical population, particularly in hearing-impaired or any major differences are existing.

**Phonological processes in children with hearing impairment**

Hudgins and Numbers (1942) (Cited in Gold, 1980) studied 192 deaf school students. The subjects were between the ages of 8 and 20 years. Their hearing losses covered a range from hard-of-hearing to profound deafness. The students were recorded while reading 10 simple sentences and evaluations were made of their skills of phrasing, accentuation, and rhythm, as well as articulation. Correlations were measured with severity of hearing loss, age, educational setting, and overall intelligibility. The various types of errors observed are illustrated here. Gold (1980) has compiled various investigations carried out to study articulatory errors under different subtypes and speech intelligibility:

1. **Consonantal Errors**

   Articulatory errors were classified in terms of those involving consonants and those involving vowels and diphthongs. Consonantal errors fell into the categories of voicing confusions, substitutions of one consonant for another, added nasality, misarticulation of abutting consonants, and omission of word initial or word-final consonants, and misarticulations of consonant blends occurred most frequently. Voicing errors usually consisted of the substitution of a voiceless cognate for the intended voiced one.
A comprehensive analysis of the speech production skills of hearing-impaired children was reported by Hudgins and Numbers in 1942 (Cited in Gold, 1980). They had reported voicing errors along with errors in consonant blends and omission of the initial consonant to have an important effect on intelligibility. Mangan (1961) (Cited in Gold, 1980) had both experienced and inexperienced listeners evaluate the speech production ability of 20 deaf and 9 hard of hearing children reading a list of familiar phonetically balanced words. A common error reported was that of devoicing of the final voiced consonants. Nober (1967) (Cited in Gold, 1980) studied 46 hard-of-hearing and deaf children between the ages of 3 and 15 years. He reported that intended voiceless sounds were more often produced correctly than intended voiced sounds. It implies that voiced sounds are harder to produce. Markides (1970) tested 83 hard of hearing and deaf children in the age range of 7 to 9 years. Test results showed that voiceless cognate was frequently substituted for voiced stops. Oller, Jensen, and Lafayette (1978) observed that the six year old hard of hearing subject either omitted final voiced consonants, devoiced them or added a /e/ after them. They claimed that this avoidance of final voiced consonants was in keeping with a phonological process used by younger normal-hearing children.

Smith (1972) (Cited in Smith, 1975) reported a reverse tendency of a greater proportion of voiced substitutions. She tested 40 deaf children. The children were asked to read 20 specially designed sentences which incorporated all of the most frequently used phonemes of English and included, whenever possible, transitions to and from the vowels /i/ /æ/, and /u/ with each of the seven places of articulation.
The words were in the expected vocabulary range of 8 years old deaf children. Voicing errors were found to be very numerous in the deaf population.

2. Omissions

Several researchers (Hudgins & Numbers, 1942; Markides 1970; Smit, 1972; Mc Garr & Osberger, 1978) (Cited in Gold, 1980) have reported that omission of the intended consonant is a frequent error type in the speech of the deaf.

3. Position of error in word

Hudgins and Numbers (1942) (Cited in Gold, 1980) reported a high incidence of consonant errors in initial position in the word. In more recent years, a greater frequency of errors on consonants in word final position has been reported. Nober (1967) (Cited in Gold, 1980) found the order of consonant errors to increase according to position in the word from initial to medial to final. Markides (1970) studied both the partially hearing and deaf children and found that the errors involving the final consonants were more numerous than errors involving initial consonants in both the groups. Smith’s (1972) (Cited in Smith, 1975) subjects also had a marked increase in the number of errors for consonants in final position over initial or medial position.

4. Consonant blends

Production of consonant blends was not always tested by the numerous examiners of deaf speech. Hudgins and Numbers (1942) (Cited in Gold, 1980) reported that the frequency of errors in consonant blends had an important effect on the listener’s ability to understand the child. The children were reported to add an additional vowel, usually /ə/, between the 2 elements of the blend, thus changing the
rhythm of the utterance, or else they eliminated one of the elements. Brannon (1964) (Cited in Gold, 1980) tested 20 deaf children and found misarticulation of consonant blends to be an important errors. Smith (1972) (Cited in Smith, 1975) tested /p,t,k/ and /s/ in blends for older children only and found omission of one element or the other of the blend to occur frequently. Oller, Jensen and Lafayette (1978) noted that their 6-year-old deaf subjects tended to reduce words to the CV level, thereby omitting parts of clusters or final sounds.

5. Place of articulation

There is general agreement in the literature regarding better production of bilabial sounds than other consonants both in isolated words and in sentences. Carr (1953) (Cited in Gold, 1980) reported deaf children to use more front consonants than back consonants and more front vowels than normal-hearing children used. Oller et al. (1978) (Cited in Gold, 1980) reported bilabialization of consonants.

Nober (1967) (Cited in Gold, 1980) tested consonant production in isolated words, found that as the place of consonant production moved further back in the mouth, the chances of it being produced correctly decreased with the exception of glottal sounds. The order of correct production of consonants which he reported was as follows: bilabials, 59%; labiodentals, 48%; glottal, 34%; linguadentals, 32%; linguopalatals, 23%; linguapalatal, 18%; and linguavelars, 12%. These findings are in fairly good agreement with the concept that those sounds which are more visible are easier for the deaf child to produce since he can rely on a sensory avenue which is functioning normally to supply him with input.
Huntington, Harris, Shankweiler, et al., (1968) (Cited in Gold, 1980) made EMG measurements from the oral articulators of 2 normal subjects and 2 deaf and they were more likely to produce a consonant correctly, if they had visual model to follow (Ex: the more visible sounds /b,m,w/). They suggested that visibility itself was not the crucial factor determining why bilabial sounds were more often correct than other consonants. They proposed that tongue movements were actually harder than lip movements and therefore, lingua–alveolar, linguadentals, and linguavelars would be hard to produce. This interpretation is also consistent with the observation cited by Nober (1967) (Cited in Gold, 1980) that the frequency of correct production of the glottal consonants is greater than that of the linguadentals, lingua-alveolar, linguapalatalas and linguavelars.

6. Errors in vowels and vowel-like sounds

Hudgins and Numbers (1942) (Cited in Gold, 1980) classified vowel and diphthong errors into 5 categories:

(i) substitution of one vowel for another,(ii) distortion of diphthongs,(iii) neutralization, (iv) diphthongization, and (v) nasalization of vowels.

Markides(1970) also reported diphthongs to be harder than vowels for the deaf children to produce. The number of distortions of diphthongs is much greater than of any of the categories of vowel errors. Diphthong errors in the deaf have been reported to be prolongation of both phoneme parts (Hudgins and Numbers, 1942), elimination of the second element (Hudgins and Numbers, 1942; Markides, 1970; Smith,1972) (Cited in Gold, 1980), omission of the first element (Mangan, 1961)
7. Vowel errors

With respect to vowel substitutions Hudgins and Numbers (1942) and Markides (1970) reported the tendency for the deaf speakers to substitute vowels that were not closely related in terms of articulatory position to the intended one. According to Mangan (1961) and Nober (1967) (Cited in Gold, 1980) back vowels as a rule, were produced correctly more often than front ones and vowels with low tongue position were correct more often than those with mid or high tongue position. This supports Boone’s (1966) (Cited in Gold, 1980) theory that the deaf have different resonance patterns because they tend to keep their tongues too far back and too low in their mouths. Thus interfering with correct production of front and high vowels but achieving better production of back and low ones.

8. Relative frequency of consonant and vowel errors

Regardless of whether children were tested on speech production in continuous speech or on isolated test words researchers have found that consonants are more often in error than vowels and diphthongs. For test words in sentences, Hudgins and Numbers (1942) reported 21% consonant and 12% vowel errors for their deaf subjects while Smith (1972) (Cited in Smith, 1975) found 53% consonant errors and 39% vowel and diphthong errors for her deaf population.

Several explanations have been offered of the higher incidence of errors reported for consonants than vowels. Brannon (1966) (Cited in Gold, 1980) claimed
that vowels are actually produced correctly more often than consonants since vowels carry more energy are easier to hear, and require less difficult tongue adjustments than consonants. On the other hand, Hudgins and Numbers (1942) noted that experimenters were less critical in determining the degree of vowel accuracy than that of consonants. The justification for this lies in the nature of the vowel itself and in degree of tolerance of the normal ear for a wide degree of vowel distortion.

Both Brannon (1966) (Cited in Gold, 1980) and Markides (1970) found more consonant than vowel errors when the phonemes appeared in isolated tested words. Markides hard-of hearing subjects produced 9% error for vowels and 72% errors for consonants. Moreover Monsen (1976) (Cited in Gold, 1980) suggested that because listeners perceive more consonant than vowel errors it is not true that the articulation of consonants per se is worse than that of vowels. If it is assumed that vowels in general convey to the listener more consonantal cues than consonants do vocalic cues, then it is reasonable that a reduction in effects of transition from one speech sound to the next may result in fewer consonants being correctly perceived than vowels.

Finally, since more consonants than vowels are generally produced in running speech there is a greater likelihood of there being more errors on consonants than on vowels. In addition to the frequency of occurrence of consonant errors compared with vowel errors, consonant errors are generally believed to be more directly correlated with overall intelligibility than vowel errors are.
9. *Speech Intelligibility*

The aim of phonological processes to simplify the adult form along with the incorrect use of individual phonemes will undoubtedly affect a child's intelligibility level. As the child begins to master individual phonemes and suppress the use of various phonological processes, speech intelligibility is likely to improve. Therefore, how understandable a child is seems to be directly affected by the development of articulation and phonological skills. Speech intelligibility is likely to vary from child to child according to its articulation and phonological development.


**Table 11: Intelligibility in different age groups**

<table>
<thead>
<tr>
<th>Age</th>
<th>Intelligibility level</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-24 months</td>
<td>25-50%</td>
</tr>
<tr>
<td>2-3 years</td>
<td>50-75%</td>
</tr>
<tr>
<td>4-5 years</td>
<td>75-90%</td>
</tr>
<tr>
<td>5+ years</td>
<td>90-100%</td>
</tr>
</tbody>
</table>

Measures of Intelligibility and severity are helpful in documenting the progress in therapy. The intelligibility of an utterance is influenced by the several factors. Connolly (1986) (Cited in Bauman-Waengler, 2004) lists the following:
• Loss of phonemic contrasts.
• Loss of contrasts in specific linguistic contexts
• The number of meaning distinctions that are lost due to the lack of phonemic contrasts
• The difference between the target and its realization.
• The frequency of abnormality in the children’s speech.
• The extent to which the listener is familiar with the client’s speech.
• The communicative context in which the message occurs.

Shriberg and Kwiatkowski (1982) (Cited in Bauman-Waengler, 2004) suggested calculating the percentage of consonants correct (PCC) for measuring the severity of involvement in children with phonological disorders. Quantitative estimates of severity using the PCC are shown in Table 11a.

**Table 11a: Degree of intelligibility**

<table>
<thead>
<tr>
<th>PCC</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;90%</td>
<td>Mild</td>
</tr>
<tr>
<td>65-85%</td>
<td>Mild-moderate</td>
</tr>
<tr>
<td>50-65%</td>
<td>Moderate-severe</td>
</tr>
<tr>
<td>&lt; 50%</td>
<td>Severe</td>
</tr>
</tbody>
</table>

Various investigations in recent years have indicated that only about 20% of the speech output of the deaf is understood by inexperienced listeners. This lack of intelligibility has been associated with some frequently occurring segmental and suprasegmental errors. The average speech intelligibility score for deaf children is poor regardless of the degree of experience of the listeners or of the extent that
conditions are like normal, face-to-face conversation. Investigations carried out by various authors regarding the speech intelligibility of the deaf are listed in Table 12.

Table 12: Studies on intelligibility of hard of hearing individuals

<table>
<thead>
<tr>
<th>Authors (Cited in Gold, 1980)</th>
<th>Subjects</th>
<th>Age</th>
<th>Stimulus used</th>
<th>Intelligibility – Judged by</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Brannon (1964), John &amp; Howarth, (1965), Markides (1970), Smith (1972)</td>
<td>Severely-Profoundly Deaf children</td>
<td>6-15 Years</td>
<td>Read the test material or spoke spontaneously</td>
<td>20%– Inexperienced listeners</td>
</tr>
<tr>
<td>2 Hudgins and Numbers (1942)</td>
<td>Hard of hearing and deaf children</td>
<td>8-19 Years</td>
<td>Read special sentences</td>
<td>29%– Experienced listeners (Children’s teachers)</td>
</tr>
<tr>
<td>4 Thomas (1964)</td>
<td>Hard of hearing subjects</td>
<td>N.D.A</td>
<td>Words, Sentences</td>
<td>10% better for words and 25% better for sentences when listeners were experienced</td>
</tr>
<tr>
<td>5 McGarr (1978)</td>
<td>Deaf subjects</td>
<td>N.D.A</td>
<td>N.D.A</td>
<td>Experienced listeners’ scores were higher than those for inexperienced</td>
</tr>
<tr>
<td>6 Monsen (1978)</td>
<td>Hearing impaired subjects</td>
<td>N.D.A</td>
<td>Read sentences</td>
<td>Experienced listeners understood 14% more than inexperienced listeners</td>
</tr>
</tbody>
</table>
A review of the relevant literature should give some insight into why these scores are so low. Markides (1970) found a correlation of -.87 between consonant errors and intelligibility and only -.66 between vowel errors and intelligibility. Although both error types correlated significantly with intelligibility, consonant errors were felt to play a more important role. The frequency of occurrence of a particular error type must be taken into consideration, when interpreting its effect on intelligibility. Although much attention has been given to the segmental errors made by the deaf, it has long been recognized the suprasegmental deficiencies contribute as much or more to the problem of poor intelligibility in the speech of the deaf.

Hudgins and Numbers (1942) (Cited in Gold, 1980) reported that those utterances marked by faulty rhythm (55% of all utterances) accounted for only 26% of all of the intelligible sentences read by their deaf subjects. However, the remaining utterances which were characterized by good use of rhythm, regardless of whether there were numerous articulatory errors accounted for 74% of all of the intelligible sentences read. Thus it would seem that if a sentence is produced with appropriate rhythm it stands a better chance of being understood. The proper rhythm or timing of

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<table>
<thead>
<tr>
<th>7</th>
<th>Mangan, (1961)</th>
<th>Deaf children</th>
<th>N.D.A</th>
<th>Read 50 familiar phonetically balanced words</th>
<th>65% Experienced listeners (teachers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Mencke, Ochsner, &amp; Testut (1983)</td>
<td>22 deaf subjects</td>
<td>8-15 years</td>
<td>Words</td>
<td>Experienced &amp; inexperienced listeners performed similarly</td>
</tr>
</tbody>
</table>

Note: N.D.A = No Data Available
speech is affected by such factors as overall rate, duration of phonemes, pausing, and grouping of syllables.

West and Weber (1973) have done a fine linguistic analysis of the phonological output of a four-year-old congenital hard-of-hearing child. In manner of articulation only the stop/resonant contrast was present; in place of articulation, only the gross labial/non-labial distinction was consistent. An important discovery was that [w] and [?] were used as coarse phonetic representatives of possible syllabic or syntactic configurations.

Oiler and Kelly (1974) reported an investigation of phonological processes of a hard of hearing child. They conducted a single case study, Ann, who was six year old. She had a moderately severe, stable, bilateral sensori-neural hearing loss. The kinds of processes found were liquid and glide processes, voicing avoidance, final obstruent devoicing, fronting of consonants. The child made occasional applications of consonant cluster reduction, assimilation of both vowels and consonants, stopping of certain fricatives, fricativization of certain other stops, and vowel substitutions. In these minor processes, they found no evidence that the hard of hearing child employed processes for which parallels do not exist in normally hearing children.

Oller, Jensen and Lafayette (1978) selected a 6-year old hard of hearing male (Frieddие) for the study. He had normal intellectual development and had a congenital profound bilateral sensori-neural hearing loss. His phonological processes appeared to be substantially the same as those that have been found in studies of younger normal children and in studies of normally hearing, language-delayed children.
All these studies revealed the phonological problems existing in children with hearing impairment. An outlook on the phonological problems in other clinical population also needs to be reviewed as these throw light on the treatment procedures to be adopted.

**Phonological processes in other clinical population**

Studies on various disordered population provide the information whether the phonological development in these groups is similar to that of the normal group or the pattern of acquisition in the clinical population rarely appear in the normally developing children.

**Mental Retardation (MR)**

Most articulation studies have focused on children in the normal range of intelligence. There have been a limited number of studies that analyzed phonological patterns in the speech of mentally retarded individuals. Lapage (1911) and Karlin and Strazrula (1952) (Cited in Mackey & Hodson, 1982) reported the most frequently defective phonemes, include /ð,θ, s,r,z,j,f,v/. Most research pertaining to speech disorders of mentally retarded individuals has been descriptive rather than analytical. Sirkin and Lyons (1941), Bangs (1942), Irwin (1942), and McGuire (1967) (Cited in Mackey & Hodson, 1982) described speech errors in terms of substitutions, omissions, and distortions.
Bodine (1974) and Smith (1974) (Cited in Mackey & Hodson, 1982) studied the phonological processes present in the speech of Down’s syndrome children and identified the following as occurring most frequently: cluster reduction, assimilation, fronting, final consonant deletion, stopping, vocalization, liquid deviations and gliding. Dodd (1977) (Cited in Mackey & Hodson, 1982) studied phonological systems of Down’s syndrome children and identified the processes which included: cluster reduction, liquid deviations, deletion of the unstressed syllable, depalatalization, gliding final consonant deletion, and vocalization. Mackay and Hodson (1982) analyzed the misarticulations of 20 mentally retarded children to ascertain which phonological processes they were utilizing most. Results compiled for all 20 mentally retarded subjects revealed three phonological processes which were particularly prevalent in the speech samples collected. These processes were; liquid deviations and cluster reduction. Other processes occurring rarely were postvocalic obstruent omission, sonorant deviations, velar deviations, stridency deletion, stopping, and devoicing of pre and postvocalic obstruents.

*Speech and language impairment*

Children with speech and language impairment appear to be at increased risk for phonological processing problems and hence literary difficulties. Schwartz, Leonard, Folger, Wilcox (1980) studied the various aspects of the phonological behavior of three normal speaking and three language disordered children, matched on the basis of mean utterance length, sex and cognitive development, were compared. The children’s spontaneous speech was analyzed. The phonologies of the normal
speaking and language disordered children were strikingly similar. Results of the investigation revealed no substantive divergence in selection constraints, production constraints, phonological processes, or phonological variability of normal speaking and language disordered children matched for mean utterance length. These results support Edwards and Bernhardt's (Cited in Schwartz, et al., 1980) conclusions that the processes evident in the speech of language disordered children are not substantially different from those evident in younger normal speaking children.

**Autism**

Autism has been described as a male dominated, developmental disability, involving pervasive linguistic and other cognitive deficits (Prizant and Duchan, 1981; Lancy and Goldstein, 1982; Ramondo and Milech, 1984) (Cited in Wolk & Edwards, 1993). Wolk and Edwards (1993) provide a detailed phonological investigation of the speech of an 8-year-old autistic boy. Phonetic inventory analysis revealed that stops, nasals and glides were generally present, whereas fricatives and affricates and the liquid /r/ were absent. There were also positional restrictions on the use of specific sounds. This information together with a phonological process analysis, revealed: (a) the existence of several phonological processes that are common in normal development, (b) the persistence of several phonological processes, (c) the occurrence of some unusual sound changes, (d) evidence of chronological mismatch and (e) restricted use of contrasts. The subject's use of phonological processes resulted in extensive homonymy, which, together with process interactions and the use of jargon, resulted in severely reduced intelligibility.
**Phonological disorders**

Studies of children whose phonological development is considered disordered have found that these children frequently use certain uncommon or idiosyncratic process, in addition to a higher incidence of common processes (Ex: Hodson and Paden 1981; Leonard 1985). Examples of uncommon process include deletion of initial consonants, deletion of medial consonants, metathesis, apicalization, backing, labialization shift, addition of a consonant and deaffrication. While the presence of these unusual processes is often interpreted as evidence that a child’s phonological system is delayed or deviant, some researchers have suggested that these idiosyncratic or uncommon processes may also be found to some degree in children whose phonological development is considered normal (Hodson and Paden, 1981; Stoel-Gammon and Dunn, 1985).

**Specific language impairment (SLI)**

Bortolini and Leonard (2000) carried out two studies wherein the phonological characteristics of preschool age children with specific language impairment (SLI) were compared with those seen in younger normally developing children matched for mean length of utterance and consonant inventory size. The productions of both English speaking and Italian speaking children with SLI were deviated from the adult standard than the productions of the younger control children. In Italian, the children with SLI had more difficulty than the younger controls in the use of non final weak syllables; in English, the children with SLI were poorer than the younger controls in
the use of non final weak syllables, word final consonants, and word final consonant clusters. These are the same phonological details that are required for several grammatical inflections and many function words in the two languages. The phonological limitations of children with SLI affirms that they will be lagging behind in other language abilities.

A few investigations have been carried out in India, where the phonological patterns in children speaking different Indian languages have been studied.

**Indian Studies**

India is a multilingual country. Adequate research is required in order to provide the normative data for each language to determine a delay/deviance in phonological development in a language disordered child. There a few studies in Indian languages where phonological processes are identified in normal and disordered population.

Sameer (1998) used the Malayalam articulation test on 30 Malayalam speaking normal children in the age range of 3-4 years. The results stated that the decreasing processes were the deaffrication, stopping, stridency deletion, fronting, reduplication, palatalization, atypical cluster reduction, medial consonant deletion, backing of fricatives, danasalization and articulatory shifts. The persisting processes in these children were cluster reduction, final consonant deletion, epenthesis, apicalization and affrication.
Sunil (1998) conducted a study on 3-4 year old Kannada speaking normal children and results indicated that children used several phonological processes during the speech sound production and these processes tend to persist even after 4 years of age. The results also showed that as age advanced from 3 to 4 years some phonological processes persisted (fronting and cluster reduction) while some other phonological processes decreased (medial consonant deletion, final consonant deletion and affrication).

Jayashree (1999) studied 30 Kannada speaking normal children in the age range of 4-5 years. She used the Kannada articulation test to elicit responses. The results were fronting, cluster reduction and stopping were found to be persisting processes whereas metathesis, palatalization, epenthesis, prevocalic voicing were the decreasing processes.

Ranjan (1999) studied 30 Hindi speaking normal children in the age range of 4-5 years. As per the results persisting processes were cluster reduction, weak syllable deletion, partial reduplication, articulatory shift, aspiration and denasalization. Some of the decreasing processes were fronting, lateralization, deaspiration, devoicing, affrication, epenthesis, backing of stop and diphthong reduction. Some phonological processes like vowel lowering and fricative replacing stop were seen only in higher age group (4:9-5 years).

Barathy (2001) studied 30 Tamil speaking children in the age range of 3-4 years. The picture form of Tamil articulation test was administered. It was seen as age advanced from 3-4 years there was a reduction in the use of processes. Frequently
occurring processes were epenthesis, cluster reduction and voicing assimilation. Unstressed syllable deletion, Gliding, Stopping of liquids, Stopping of fricatives, fronting, final consonant deletion, initial consonant deletion, nasal assimilation and deaffrication were least occurring phonological processes.

Mala (2001) administered Kannada articulation test to 3-4 year old Tulu-Kannada speaking normal children. The results showed that the bilinguals have fewer phonological process in some patterns such as affrication, fronting, cluster reduction, stopping, initial consonant deletion, medial consonant deletion whereas monolinguals had fewer phonological processes in other categories such as vowel unrounding and final consonant deletion.

Santosh (2001) studied phonological development of normal 3 to 4 year old Hindi speaking children. All the children in this age group used greater number of phonological processes during acquisition of the speech sounds of their language. As the age advanced, some of the phonological processes decreased in frequency. These are stopping, stridency deletion, final consonant deletion, weak syllable deletion, affrication, denasalization, deaffrication and final consonant devoicing. Some phonological process which persisted are cluster reduction, epenthesis and fronting. Some phonological processes like gliding, metathesis, nasalization, velar assimilation, alveolar assimilation, labial assimilation and coalescence tend to be suppressed in 3.5 to 4 years of age. Some uncommon processes, initial consonant deletion, metathesis, backing were also seen.
These studies show that there are universal tendencies in children’s phonological acquisition. However, language specific features play an important role in determining the phonological development of the children of a given language. Some of the Indian studies have focused on the clinical population which are described here.

Anita (2000) studied 10 normal and 10 mentally retarded Tamil speaking children with a mental age of 5-6 years. Mentally retarded children showed the same phonological processes as normal children but it was delayed. Fronting was the most frequently occurring phonological process.

Jasmine (2001) carried out a study on 20 Malayalam speaking moderately-severe to severe hearing-impaired children. Ten subjects were in the age range of 3-5 years and another ten in the age range of 5-7 years. In the age range of 3-5 years normal children showed 13 phonological processes whereas the hearing-impaired children showed 25 phonological processes. Comparing 3-5 and 5-7 year old hearing-impaired children, 25 phonological processes were seen in the former group and 15 in the latter group. This indicates phonological processes decrease with age.

Harneesh (2001) studied a child with developmental apraxia of speech (DAS) of 6 years 3 months and a normal child of 6 years 3 month old. The results showed that the phonological processes exhibited by the DAS child and normal child were different. The normal child exhibited a few natural processes and a few unusual ones such as denasalization and vowel assimilation. In both the children, process named aspiration was noticed. The DAS child showed certain processes which were not
reported in literature. They are aspiration, addition of /l/, final consonant addition, medial consonant addition, fricative addition, initial vowel addition, initial vowel prolongation, initial vowel deletion, final vowel deletion.

The different stages in the normal phonological development play an important role in the emergence of phonological assessment. Studies on normal and clinical population have lead to the development of various assessment procedures which helps in diagnosis and intervention aspects of phonological disorders. Hence, there is a great need to know about phonological assessment in depth.

TOOLS FOR PHONOLOGICAL ASSESSMENT

Linguists and Speech-language pathologists have made a unique contribution to the assessment of verbal behavior through the development of phonological assessment instruments. Evaluation of an individual’s phonological status involves description of his/her speech sound production system and relating this system to the adult standard of the speaker’s linguistic community. Phonological assessment is carried for:

- Description of the phonological status of an individual and determination of his/her speech sound system.
- Decision of treatment direction and strategies to be used in the management of the client.
- Prediction and prognosis of phonological change with or without intervention.
- Monitoring change in phonological performance across time.
Identification of factors that may be related to the presence or maintenance of a phonologic disability.

In order to make these determinations, the clinician engages in a multi-step process that involves sampling the client’s speech through a variety of procedures, analysis of the data, interpretation of the data, and then making clinical recommendations and decisions.

**Phonological assessment procedures**

These include screening measures and comprehensive assessment tests.

**I. Screening for Phonological disorders**

Screening procedures are not designed to determine the presence or absence of a phonological disorder and to determine the need or direction of therapy, but rather to differentiate individuals who merit further evaluation from those for whom further evaluation is not indicated. Comprehensive phonological testing is time consuming. Hence, frequently, a clinician will do a screening to determine if a more comprehensive assessment of this nature is warranted.

**II. Comprehensive Phonological Assessment**

A complete phonological evaluation typically involves phonological productions in samples of varying lengths, phonetic contexts, and in response to various elicitation procedures. This collection of samples is often referred to as an Assessment Battery. The various methods adopted to obtain samples comprising a phonological assessment battery are described here. The goal of phonological
assessment procedures is to obtain a speech sample that reflects the child’s abilities in varying contexts and situations in order to optimize assessment and treatment.

1. **Connected Speech Samples**

   All phonological evaluations should include a sample of connected speech. Sounds produced in connected speech may also be studied in relation to other factors such as speech rate, intonation, stress, and syllable structure. A connected speech sample is a crucial part of any phonological assessment battery because it allows

   - assessment of overall intelligibility
   - determination of speech sound usage in its natural form
   - a database from which to judge the accuracy of individual sounds, patterns of errors, and consistency of misarticulations.

   The preferred method for obtaining connected speech samples is to engage the client in spontaneous conversation. If, for some reason this cannot be accomplished, alternate procedures that can be used include the following:

   - conversational responses elicited via picture stimuli or objects
   - utilization of a reading passage
   - telling a story following the clinician’s model (delayed imitation)

   **i. Spontaneous conversation**

   The customary and preferred method for obtaining a sample of connected speech is to engage a client in spontaneous conversation. The clinician may talk with the client about such things as hobbies, television shows, or places the client has
visited. The samples should be tape-recorded so that the clinician can play them back as often as required to accurately transcribe the client’s utterances. Clinicians should make notes about topics covered and errors noted to facilitate later transcription. Some clinicians suggest that phonological analyses should almost exclusively be based on this type of sample, because spontaneous connected speech samples are the most valid or representative sample of phonological performance (Shriberg and Kwiatkowski, 1980; Stoel-Gammon and Dunn, 1985).

Spontaneous conversation tests the child’s performance in the most real-life natural communication. However, spontaneous conversation has several weaknesses that may limit the clinician’s full use of this assessment method. In a clinical setting, children may simply be unwilling to cooperate, may be too shy to engage in spontaneous conversation, or may have behavioral complications, which make it impossible. Moreover, speech output from a highly unintelligible child may be difficult to transcribe or it may be difficult for the clinician to determine the target word. Children may also deliberately avoid certain sounds with which they know they have difficulty, or avoid certain phonetic contexts. Finally the sample will be different both between and within children. This can pose problems in research and make it more difficult for a clinician to evaluate a child’s performance systematically over time, thus limiting prognostic and treatment outcome evaluations.

**ii. Reading passage**

Some clinicians have the client read a passage orally as an alternative method for obtaining a connected sample of speech. Although this procedure provides a
sample of connected speech, it has been demonstrated that, usually, fewer errors occur in a sample obtained in this manner than in a corpus of conversational speech (Wright, Shelton, and Arndt, 1969) (Cited in Bernthal & Bankson, 2004). Moreover, clinicians frequently test children who have not yet learned to read, in which case this procedure is obviously not a viable option.

iii. Delayed imitation task

Some speech sound inventories specify procedures for obtaining a sample of connected speech. For example, in the “Sounds-in-Sentences” subtest of the Goldman-Fristoe Test of Articulation (1969, 1968), the client listens to a story while viewing the accompanying pictures and is then asked to repeat the story. Such a delayed imitation task is designed to elicit particular sounds in certain phonetic contexts. A variation of the delayed imitation method is the sentence repetition technique in which the clinician verbalizes a sentence containing a target sound and instructs the client to repeat it. A more spontaneous method than either the immediate or delayed imitation technique is for the client to tell a story about a series of pictures selected to elicit target words and sounds.

Healy and Madison (1987) in their study compared frequency and type of articulation error in 20 normal hearing children in the age range of 5 to 12 years. They found that connected speech samples revealed numerically more omission errors, more substitution errors, and more distortion errors than single word samples, though the distribution within conditions was similar. The increased frequency of articulation errors in connected discourse as compared to single words has been reported

These studies suggest that the speech/language clinician is well advised not to rely only on single word sampling methods when evaluating articulation disorders. Based on results consistent with the study, Johnson et al. (1980) (Cited in Healy & Madison, 1987) recommended that “…decisions pertaining to diagnosis, prognosis, remediation, planning and discharge should be predicted on representative continuous speech samples.”

2. Single word Productions

The customary way to elicit single-word productions is through the administration of a single-word articulation test (sometimes called a speech sound inventory), where a client names single words in response to picture stimuli. Single words may also be obtained by having a child name toys or objects. Such instruments typically sample consonants, consonant clusters, and occasionally vowels and diphthongs. Consonants are usually assessed in the initial, medial, and final positions of words, for example, /s/ in saw, pencil, house; /ʃ/ in shoe, station, fish.

The major strengths of single word naming are:

- it is usually simple and relatively easy to administer
- it is easy to determine the target word and easy to transcribe, especially in the case of a highly unintelligible child, because of a predetermined word list and lack of confounding factors from the phonetic environment
• a predetermined word list provides control over the speech sample (i.e., the list can be specially designed to elicit sounds in a variety of word positions and phonetic contexts)

• single word naming facilitates comparison between children or in one child longitudinally, because data are based on a single measure.

The major weakness often discussed is that naming may overestimate a child’s true abilities and thus fail to reflect his/her performance in real-life communication (DuBios & Bernthal, 1978; Faircloth & Faircloth, 1970; Ingram, 1976; Smith & Ainsworth, 1967; Stoel-Gammon & Dunn 1985) (Cited in Wolk & Meisler, 1998).

Dubois and Bernthal (1978) compared the speech-sound productions elicited from children identified as having articulation errors using three different sampling procedures. The three procedures were (1) Continuous speech Task (CST), in which responses were elicited via spontaneous continuous speech, (2) modeled Continuous speech Task (MCST), which responses were elicited via delayed imitation or modeled continuous speech, and (3) Spontaneous picture-naming Task (SPNT), in which responses were elicited via spontaneously produced single words. This study also compared the administration time required to obtain each of the three speech samples. The SPNT elicited significantly fewer articulation errors than either of the continuous speaking tasks but required significantly less administration time and pointed out the efficiency of the picture-naming method. Comparison of the two connected speech-sampling methods showed that the MCST required less time to administer but elicited
significantly fewer errors than the continuous speech task. The CST required the longest administration time and elicited more speech-sound errors than the MCST.

Paden and Moss (1985) found no differences in the phonological processes occurring at the 50% level regardless of the type of speech sample used by three subjects. Watson (1989) (Cited in Wolk & Meisler, 1998), found no differences in the phonological processes identified in eight articulatory disordered children relative to the type of speaking condition.

From these findings, it is difficult to draw conclusions regarding the superiority of one method over the other. One problem in interpreting the results of these studies is the use of various assessment procedures for naming, thus making it difficult to compare across studies. Moreover, many of the naming procedures used have been limited with respect to phoneme selection (particularly consonant clusters), phonetic environment, and syllable structure. Although several studies have attempted to systematically compare naming and spontaneous conversation, few studies have employed an extensive picture naming task (PNT) that adequately controls for phonetic environment while providing in-depth phonological analyses.

Klein (1984) (Cited in Dubois & Bernthal, 1978); Paden & Moss (1985) have highlighted the major practical limitation of using conversational speech tasks in clinical practice. Klein (1984) (Cited in Dubois & Bernthal, 1978) supports more detailed analyses of conversational speech to be undertaken along with early treatment sessions in order to supplement findings from a picture naming task. Wolk and Meisler (1998) compared the number and nature of phonological error patterns using a
conversational speech task (CST) and an extensive picture naming task (PNT) in a
group of phonologically disordered children. Results indicated that overall profiles of
phonological behavior were similar on both tasks but that the naming procedure
yielded more phonological errors. Andrews and Fey (1986) (Cited in Wolk and
Meisler, 1998) found that the similarities in their children’s (n=14) performances on
the two tasks (naming versus conversation) were far greater than the differences.

These studies suggest that estimation of severity of phonological impairment
may be determined more by the complexity of the task than by its nature. Thus, when
a naming task is designed carefully with adequate complexity, it may test the child’s
phonological abilities more comprehensively than conversational speech. In
conclusion, conversational speech has often been referred to as the “ideal” methods of
elicitation because it represents the child’s natural connected speech and allows for
influence of phonetic context. Although this may be true, a carefully designed picture-
naming task may tap the child’s phonological system more deeply and provide the
clinician/researcher with maximum control over the speech sample to obtain a richer
body of data. Therefore, an extensive picture-naming task may provide a good sample
of phonological behavior while avoiding difficulties inherent in the collection and
transcription of conversational speech.

3. **Stimulability Assessment**

A third sample of speech sound production is obtained through stimulability
testing which means, sampling the client’s ability to repeat the correct form (adult
standard) of errors sounds when provided with “stimulation”. A commonly used
procedure has the examiner asking the respondent to imitate an auditory and/or visual model of a sound, syllable, or word containing the adult form of the segment. There are no standardized procedures for conducting this type of testing. The examiners typically seek to stimulated production at three levels; sound in isolation, sound embedded in syllables, and sound embedded in words. Stimulability testing has been used to predict (1) whether or not a sound is likely to be acquired without intervention, and (2) the level of phonetic production at which instruction might begin (e.g., isolation, syllables, or words). In other words, these data are often used when making decisions regarding case selection and speech sounds targeted for treatment.

4. Contextual Assessment

Assessing contextual influences is based on the concept that sound productions influence each other in the ongoing stream of speech. McDonald (1964) (Cited in Bernthal & Bankson, 2004) suggested that valuable clinical information could be gained by systematically reviewing a sound as it is produced in varying contexts and coined the term deep test to refer to the practice of testing a sound in a variety of phonetic contexts. Contextual testing is done primarily to determine phonetic contexts in which a speech sound error may be produced correctly. These contexts may then be used as a starting point for remediation. Contextual testing is also used as a measure of consistency of misarticulation.
5. Error pattern identification (Pattern Analysis)

Procedures designed to provide a composite of individual productions are sometimes referred to as pattern analysis and is employed in clients with multiple errors. Many clinicians employ a phonological process analysis to facilitate error pattern delineation in clients who evidence multiple phonological errors. A phonological process or pattern is typically defined as a systematic sound change or simplification that affects a class of sounds, a particular sequence of sounds, or the syllable structure of words. Response elicitation procedures may be picture naming or conversational speech. The type of scoring and analysis of either type of sample is designed to identify the presence of phonological process/phonological patterns among errors. These error patterns frequently affect entire sound classes, particular sound sequences, or the syllable structure of words. Clinicians compare the child’s productions with the adult standard into phonological patterns.

One of the reasons pattern analysis procedures have appeal is that they provide a description of the child’s overall phonological system. A second reason for doing a pattern analysis is the potential for facilitating treatment efficacy. When a pattern reflecting several sound errors is targeted for treatment, there is the potential for enhancing rapid generalization across sounds related to that pattern. Systems of pattern analysis, whether based on a place-manner-voicing analysis, distinctive feature analysis, or the more commonly employed phonological process analysis procedures, are most appropriate for the client who has multiple errors.
Some investigators have called for quantitative criteria to be used in determination of phonological processes. McReynolds and Elbert (1981) (Cited in Bernthal & Bankson, 2004) suggested that some percentage of occurrence of a process be applied in determining if a given error pattern constitutes a phonological process.

Hoffman and Schuckers (1984) (Cited in Bernthal & Bankson, 2004) have attempted to explain the occurrence of phonological processes. One explanation for the occurrence of that process might be that the child misperceives the adult word. A second explanation might be that the child’s underlying lexical representation for a word might be something which has a closest match in his store of lexical items is. A third possible explanation is that the child’s perceptual system functions appropriately and the lexical match between what the child perceives and what he or she as stored is consistent with the adult standard, but he or she has a phonological production rule that calls for the deletion of word-final stops. A fourth possibility is that the child has a motor production problem, in which the child may have the appropriate perception but does not possess the necessary motor skill to make the articulation gesture to produce the sound.

The five types of assessment instruments and procedures identified such as connected speech, single words, stimulability, contextual and pattern analysis are all part of a phonological assessment battery. No one measure is likely to provide all the information needed by the clinician, and thus a battery of tools must be used.
Criteria for selecting phonological assessment instruments

Speech-language pathologists have at their disposal a variety of published phonological assessment instruments. Although clinicians often tend to use particular assessment tools, most recognize that no one test is appropriate for all purposes. The test instruments selected should be appropriate to the individual being tested and provide the information desired by the clinician. When selecting instruments for phonological assessment, the clinician will want to consider the sample the instrument is designed to obtain, the nature of the stimulus materials, and the scoring and analysis system. A practical consideration in test selection is the amount of time required to administer the instrument and analyze the sample obtained.

Sample obtained

A factor to consider in selecting a test instrument is the adequacy or representativeness of the speech sample obtained. The specific consonants, clusters, vowels, and diphthongs tested as well as the units in which they are produced (i.e., syllables, words, sentences). The model of stimulus presentation sample elicitation (Ex: picture-naming, imitation, delayed imitation, conversation) should also be considered when selecting instruments.

Material presentation

Another practical factor in test selection is the attractiveness, compactness, and manipulability of the test materials. Size, familiarity, and color of stimulus pictures and appropriateness for the child’s age sometimes influence the case with which one obtains responses to test stimuli. In addition, the organization and format of
the scoring sheet are important for information retrieval. Tests with familiar and attractive stimulus items and score sheets that facilitate error analysis are desirable.

*Scoring and Analysis*

Because the scoring and analysis procedures that accompany a test instrument determine the type of information obtained from the instrument, they are important considerations in test selection.

Considering these criteria, many procedures for phonological assessment were developed. Some of these which are based on phonological processes are described in the following section.

1. **Assessment of Phonological processes-Revised (APP-R)**

   Hodson (1980) (Cited in Hegde, 2000) developed the assessment of phonological processes (APP) in 1980 and revised the original version in 1986. The revised one is unique among phonological tests in that, it was not designed to identify phonological disabilities but to identify priorities in the treatment of unintelligible children.

   The APP-R uses objects, pictures, and body parts to elicit 50 target responses by having the client name the various materials as they are presented. They are common household objects that can be easily collected by the examiner. Picture cards are included for things that are not collectible such as for the word smoke. The test is structured to score over 40 phonological processes. The client’s transcribed production of the 50 stimulus words is scored for the presence of various processes listed in a
matrix format. Analysis of the APP-R derives a Frequency of Occurrence Score, Percentage of Occurrence Score, Severity Rating, and Composite Deviancy Score. According to the information in the test manual, the APP-R can usually be administered in 20 minutes. One drawback of the procedure is that spontaneous speech or continuous speech is not considered which is the representative of client's productions.

**ii. Bankson-Bernthal Test of Phonology (BBTOP)**

Bankson and Bernthal (1990) (Cited in Hegde, 2000) developed the Bankson-Bernthal test of phonology. The test was designed to describe consonant productions and the use of phonological processes in preschool and early school-aged children. A picture-naming format is used to elicit 80 stimulus words designed to analyze the following phonological processes: assimilation, fronting, final-consonant deletion, weak-syllable deletion, gliding, cluster simplification, depalatalization, deaffrication, and vocalization. The test is standardized for children between the ages of 3 and 6, but it can also be administered to older school age children with severe phonological or articulation problems.

Some of the drawbacks in the procedure is that picture naming is adopted, which is not the representative of client's productions. Also vowels are not included in the phoneme inventory for testing. Though consonants are incorporated, consonants in the medial word position is not tested.
iii. The Khan-Lewis Phonological Analysis (KLPA)

The Khan-Lewis phonological analysis was developed by Khan and Lewis in 1986. It uses the 44 words from the Goldman-Fristoe test of articulation sounds in words subtest as testing stimuli. The KLPA was designed to identify the phonological processes that account for various types of errors by preschool children. These include 12 developmental processes. It provides the following measures: Developmental Phonological Processes Rating, Speech Simplification Rating, Percentile Rank, Age Equivalents, and a Composite Score. In combination with the GFTA, the Khan-Lewis phonological Analysis makes possible a phonetic and phonological analysis of the client’s articulatory system.

The KLPA was designed to assess the speech of children ages 2 through 5. However, the authors indicate that this analysis may also be used to identify specific phonological processes for remediation in children 6 years and older. Here spontaneous speech was not considered but picture naming was adopted in the test procedure. The disadvantage is speech production was assessed in single words not in continuous speech, which is natural.

iv. Assessment Link Between Phonology and Articulation (ALPHA)

Lowe (1986) developed the assessment link between phonology and articulation. It gives the examiner the option of scoring the client’s production using a traditional (omission, distortion, substitution) or a phonological processes format, or both. The test elicits 50 target words by using delayed sentence imitation along with
black and white line drawings. The client’s productions are transcribed onto the test protocol using whole-word phonetic transcription. These are then scored for sound changes in word-initial and word-final positions. The words are also analyzed for the occurrence of phonological processes. The ALPHA was designed for administration to children 3 years of age and older. Only the consonants in the initial and final word position are tested and consonants in the medial position are excluded.

The highlights of a few phonological assessment models are illustrated in the Table 13.

**Table 13: Characteristics of the published phonological assessment procedures**

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<td>Stimuli</td>
<td>3-dimensioanal objects</td>
<td>Pictures from the Goldman-Fristoe Test of Articulation</td>
<td>Pictures from the Bankson-Bernthal Test of Phonology</td>
<td>Photographs from the Smit-Hand Articulation and Phonology Evaluation</td>
<td>Embedded target words-picture stimuli</td>
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<td>Elicitation procedures</td>
<td>Object-naming; no set order</td>
<td>Picture-naming in citation form</td>
<td>Picture-naming in citation form</td>
<td>Photograph-naming in citation form</td>
<td>Delayed sentence imitation-picture stimuli supplemental 50 words</td>
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<td>Sample size</td>
<td>50 single words</td>
<td>44 single words</td>
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<td>Transcriptiion</td>
<td>Broad transcript ions modified; audiotaped for reference</td>
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v. Phonological process analysis (PPA)

Weiner (1979) describes the phonological process analysis as a speech sampling procedure especially useful in assessing the speech of highly unintelligible children. The test uses delayed imitation and sentence recall along with action picture presentation to elicit the target words both as single words and in the context of sentences. The PPA analyzes various phonological processes and categorizes them according to syllable structure, harmony, and feature contrast processes. The proportion of occurrence of the tested processes is determined along with the frequency of occurrence of non-test processes.
vi. Natural process Analysis (NPA)

The natural process analysis was developed by Shriberg and Kwiatkowski (1980). The eight natural processes were selected for analysis and these occur frequently in preschool and school-aged children with delayed speech. Continuous speech samples collected by the examiner serve as the information for analysis. The connected speech sample is tape-recorded live for later analysis. Between 80 and 100 different words from the sample are transcribed on to the NPA transcription sheet. The words are analyzed both phonetically and phonologically. The phonological processes being used, the stage of development the processes are in, and what phonetic contexts influence the occurrence of the process are determined. The NPA is not normed, but the authors provide a detailed appendix on the acquisition of phonology for comparative analysis.

vii. Phonological profile (PROPH)

Crystal’s (1982) (Cited in Ball & Muller, 1997) segmental phonological profile PROPH contains a bundle of different profiles using phonetic parameters only as the measurement of behavior. The first page of PROPH chart contains space at the top for the usual information on the patient and the sample where accent features can be noted. The rest of the first page is for recording in phonetic transcription of the words of the sample. Most of these will be entered on to the grid numbered 1 to 100. The sample recommended is the interaction between patient and therapist and spontaneous
speech. However, output from picture elicitation tests could also be used if that was felt appropriate to the stage of phonological development of the particular patient.

Each different word is written in ordinary orthography next to the number, and the transcription is entered in the space to the right. At the bottom of this page there is a summary section where the total number of different words profiled as a ratio of the over all total and the number of words left unanalyzed due to problems are recorded. Following this, there is a two chart covering the phonological units of the English sound system, and the main consonant clusters. The groupings are divided into syllable-initial, syllable-final, vowels, syllable-medial, stress and features occurring between words. Each of the consonant boxes is divided vertically between voiceless and voiced sounds and horizontally between plosives, affricates, fricatives, nasals and approximates. The vowel box is organized into front vs. back vowels, high vs. low vowels and monophthongs vs. diphthongs. Consonants and vowels in stressed and unstressed syllables are entered in separate boxes. The three vertical divisions are from left-to-right, correct, omitted and distorted/substituted. This chart has an area for marking the use of stress in bisyllabic and polysyllabic words.

The main profiling chart can be difficult to read, as it contains a mass of information. Crystal has added three supplementary pages to aid clarity, which contain four main types of information: a phone inventory. A classification of these phones in terms of the adult target phones, a phonological feature and process analysis and a section for any further analyses. The inventory gives account of the phonetic ability of the patient. The number of correct responses of the patient can be known
from the target analysis. With the single consonant system, place and manner features are analyzed separately and correct, omitted and substituted instances are listed on the left hand grid. The precise nature of errors is then entered on the right hand grid showing what feature was substituted for the correct one. The process analysis is very simplified with a set of process types (divided into syllable structure and assimilation and substitutions) being listed. Unlike other profiles, PROPH does not give the phonological process a leading role in the analysis of the patients phonology.

PROPH has many advantages over other procedures, in that it has a variety of approaches from which the therapist can choose a particular therapeutic procedure. The inventory of phones doesn’t take into account the patients own phonological system. The profile shows the presence of vowel problems also.

**viii. Phonological analysis of child speech (PACS)**

Grunwell’s (1985) phonological analysis of child speech shares a common approach to that of PROPH in many respects. They both use patient’s natural speech as input and they both utilize sets of different analyses to investigate these data. According to Grunwell (1988) (Cited in Ball & Muller, 1997), PACS is an adequate phonological profile as it includes the following: (a). Analysis of child’s phonetic inventory. (b). Analysis of child’s use of this phonetic inventory at different positions in word and syllable structure and the combination of consonants that occur at these structural positions. There are charts dealing with a distinctive feature analysis, assessment of loss of phonemic contrasts, assessment of variability and assessment of homophony. PACS is solely concerned with consonants. Vowels are excluded. PACS
recognizes four word positions: Syllable initial, word initial, syllable initial within word, syllable final within word and syllable final, word final.

The first of the analysis charts contains the patient’s phonetic inventory and phonetic distribution. This inventory enables the clinician to analyze the patient’s phonetic capabilities without regard to the target realizations or to the phonological use these phones may be put to. The upper table arranges the patient’s phones in terms of place and manner labels, while the lower table shows where in the word structure these phones occur in singletons and in clusters. The second core chart continues the analysis of a child system, but introduces explicit contrasts with the adult target system. The clinician needs to work out the phonological units used by the child to signal differences of meaning.

The next two core charts provide in-depth coverage of the phonotactic capabilities of the patient. The first chart shows a wide range of phonotactic possibilities in monosyllables, disyllables and polysyllables. The second chart allows the clinician to summarize this information and to show what phones the child used for certain common adult target consonant clusters. The remaining charts constitute the developmental metric of PACS. They include a wide range of the phonological processes in the analysis. The charts allow for noting the use of each process along with the examples and the frequency of use in potential environment. The final core chart provides for the developmental assessment of the patient which gives seven chronological stages from 0.9 to 4.6+. Hence a patient’s phonological stage can be determined. PACS evaluates the phonological patterns found in the patients, which
Grunwell points out as delayed development, uneven development and deviant development. A couple of charts investigate communicative adequacy, which is used to assess variability and homophony.

The two profiles, PROPH and PACS take longer time to administer and analyze than most standardized tests. They require a larger data set and considerable time and effort in transcription for a phonological profile. Both the profiles guide the therapists in decisions over prioritizing items for therapy. However, there is a major difference of scale between the two profiles. Completing all PACS charts require more time than a full administration of PROPH. PACS consists over a dozen different profile charts and a major difference of assessment goals. While PROPH uses phonetic and phonological metrics, PACS explicitly adds developmental and communicative adequacy measures.

**ix. Phonological profile for the hearing-impaired**

Vardi (1991) developed the manual, phonological profile for the hearing impaired. It was designed to use with the individuals having hearing impairment. The overview of the phonological profile is detailed below:

The inventory covers vowels, diphthongs, clusters, consonants and is divided into developmental stages. This allows an assessor to see whether or not a child is following a normal hearing developmental pattern. The vowels are classified according to low/high and front/back. The diphthongs are placed according to their starting point. The clusters are divided into two or three consonant cluster categories.
The cluster analysis is divided into initial, medial and final positions. The consonants are analyzed according to position in the word, place/manner analysis and developmental model. The boxes allow for the transcription of vowels, consonants and clusters of what the child actually produced. The assessor notes all the substitutions, distortions or omissions that occur when the child produces the target sounds. In the consonant inventory, next to each consonant there is a line. This allows for the recording of the substitution process that occurs for that particular consonant. These processes may be normal process or idiosyncratic process. Vardi has illustrated processes in normal children and in deaf speakers arranged developmentally (Grunwell, 1982; Ingram, 1976; Stoel-Gammon & Dunn, 1985) (Cited in Vardi, 1991) in different stages. The details are as follows:

**Stage 1. (2.06 years)**

Final consonant deletion, unstressed syllable deletion, cluster reduction, assimilatory processes, reduplication, velar fronting, gliding, stopping and voicing.

**Stage 2. (3.06 years)**

Normally disappearing processes - Final consonant deletion, assimilatory processes, reduplication, velar fronting, stopping of /f,s/ and voicing.

Normally persisting Processes - Unstressed syllable deletion, cluster reduction, gliding, stopping of /v,z,ð,dz/ 

Emerging processes-Depalatalization.
Stage 3. (4.06 years)

Normally disappearing processes - Unstressed syllable deletion, gliding of /l/, stopping of /v, z, ɹ, dz/ and depalatalization.

Normally persisting processes- cluster reduction, gliding of /ɹ/

Emerging Processes-Deaffrication, affrication.

Stage 4 (>4.06 years)

Remaining process are resolved.

Processes seen in deaf speakers are as follows:

Backing, devoicing, palatalization, nasalization, denasalization, bilabialization, sound intrusion, initial consonant deletion and glottal replacement.

There are separate sections for syllable structure and assimilatory processes. There is a qualitative section, which covers voice and suprasegmental features. Intelligibility scale is also incorporated in the profile. The scale reflects the number of words, which could be accurately understood over the total number of words spoken. The resulting percentage is transferred to the scale.

The stimuli picture booklet consisting of 54 words is shown to the child to elicit stimuli words. In addition, fifteen to twenty-five spontaneous utterances are collected through discussion or play or using some stimuli word cards. Assessor marks a tick in stimulus word scoring sheet, if all aspects of phonology is correct. If not, the entire word is transcribed. After detailed analysis from the data sheets, the information is transferred to the phonological profile. The profile gives a phonological summary. The phonological summary provides the compact information about the
production of vowels, diphthongs, clusters, and consonants in terms of place, manner and processes. It reveals information about voice, prosody and intelligibility. The summary is not a list of all the subject’s problems, but rather a shortened list of potential goals. The profile determines the stage the child is in the normal phonological development. The summary asks the assessor to focus on the most appropriate consonants the assessor feels the subject needs to work on. The profile provides the step-by-step goals from a place/manner point of view, from a process point of view, from developmental point of view towards the management of the subject. As the profile is language specific, it can be applied only for English speakers.

x. Computer-Assisted Phonological Analysis

Any discussion of phonological analysis and interpretation would be incomplete without calling attention to the fact that there are computer-based programs designed to assist with the analysis of phonological samples in clients who exhibit multiple errors. Masterson and Long (2004) indicated that there are two primary reasons for using a computer-based analysis of a phonological sample: (1) it saves time, and (2) it provides greater details of analysis than one typically produces with traditional paper and pencil (manual) analysis procedures. Computer phonological analysis (CPA) software involves in putting phonetic transcriptions from a computer keyboard and/or by selecting from predetermined stimuli, displaying this data on the screen, and ultimately printing results of an analysis. Analyses often include both relational and independent analyses of consonants and vowels, word
position analysis, syllable shapes used patterns among errors, and calculation of percentage of consonants correct. Each of the current programs has its own strengths and limitations, and undoubtedly future procedures will add new and helpful procedures for clinicians.

The computerized Articulation and Phonology Evaluation System (CAPES) (Masterson and Bernhardt, 2002) (Cited in Masterson & Long, 2004) is a good example of a system that was developed to elicit and analyze phonological productions. CAPES includes an online single-word (SW) elicitation task that is tailored to the client's phonological level. The SW task begins with a profile of 47 words (presented as picture files on the computer). The client's responses to those words are analyzed in order to select an additional set of words, the Individual Phonological Evaluation (IPE), for presentation. Four IPEs represent different phases of phonological development, from the earliest word structures and phonemes at Level 1 to complex multisyllabic words at Level 4. In addition to the SW elicitation task, CAPES allows the input of connected speech or user-constructed word lists or sentences. Video clips are available for elicitation of connected speech.

The CPA programs are Computer Analysis of Phonological Processes (CAPP) Version 1.0 (Hodson, 1985), Computer Profiling (CP) (Long & Fey, 1988), Logical International Phonetic Programs Version 1.03 (LIPP) (Oller & Delgado, 1990), The Macintosh Interactive System for Phonological Analysis (Mac-ISPA) (Masterson and Pagan, in press), Process Analysis Version 2.0 (PA) (Weiner, 1986), Pye Analysis of Language Version 2.0 (PAL) (Pye, 1987), and programs to Examine Phonetic and
6. Assessment of vowels

An area of phonological assessment that has received little attention in the literature is that of the assessment of vowels. Undoubtedly this is a reflection of the fact that most children with phonological disorders have problems primarily with consonants. In addition, vowels are typically mastered at a relatively early age and are seldom misarticulated by children. Phonological assessment instruments have placed little emphasis on vowel assessment, although some speech sound tests do sample vowels.

7. Additional Assessment Procedures

A comprehensive assessment includes measures as taking case history, oral cavity examination, hearing testing, and perceptual testing.

Case History

In order to facilitate an efficient and effective assessment, a case history is obtained from the client or a parent. This will allow the clinician to identify possible etiological factors, the family’s or client’s perception of the problem, the academic, work, home and social environment of the client; and medical, developmental, and social information about the client. Case history information is usually obtained through a written form completed by the client or parents. It may also be obtained or at least supplemented, by an interview. Specific questions regarding the phonological
status of a young child might include the following: (1) Did your child babble? Can you describe it? (2) When did your child say his or her first words? What were they? When did he or she start putting words together? (3) Describe your child’s communication problem, and your concerns about it. (4) How easy is your child to understand? By the family? By strangers? (5) What sounds does your child say? (6) What do you think caused your child’s speech difficulty?

While case histories obtained from the client or the client’s family are products of memory and perception, and thus may not reflect total accuracy. Parents and clients, in general, are reliable informants. In spite of its shortcomings, the case history provides the clinician with important background information that frequently influences assessment decisions and subsequent management recommendations.

**Oral cavity examination**

Oral cavity examinations are administered to describe the structure and function of the oral mechanism for normal speech purposes. In particular, dentition is observed for bite and missing teeth: hard and soft palates are examined for clefts, submucous clefts, fistulas, and fissures. Size, symmetry and movement of the lips, the tongue and soft palate are examined.

In an oral cavity examination, in which the clinician notes an inadequacy of structure or function, which might contribute to the articulation disorders, he or she has several options: (1) refer the client to other professionals (Ex: ENT physician, orthodontist) for assessment and possible intervention. (2) engage in further observation and testing to verify the earlier observation and note its impact upon
speaking skills, and (3) provide instruction related to compensatory or remedial behaviors.

**Hearing testing**

The primary purpose of audiological screening is to determine whether a client exhibits a loss of auditory function, which could be an etiological factor associated with a phonological disorder. Audiological screening is usually conducted with pure tones and/or impedance audiometry. Impedance screening yields basic information about functioning of the tympanic membrane and the middle ear. The client who fails a pure tone or impedance screening test should be referred to an audiologist for a complete audiological assessment.

**Speech sound discrimination testing**

For many years, clinicians assumed that most children with articulation errors were unable to perceive the difference between the standard adult production and their own error production, and they inferred that many phonological problems were the result of this faulty perception. Recent research has declined the routine use of speech sound discrimination tests.

Many scholars have put forth different phonological assessment procedures. Each procedure emphasizes certain phonological aspects. Profiles cannot be used for other language population other than the population it is designed for. Hence, in the present study an attempt has been made to develop a Phonological profile in Kannada, which would lead to comprehensive phonological assessment of Kannada speaking children. Hence, the present study was taken up.