LSHSS

Clinical Forum

A Whole-Word Approach to Phonological Analysis and Intervention

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The difference between perception and reality is captured amply by the old observation that a glass half-filled with water can be described as either half-empty (the pessimist) or half-full (the optimist). The water level is the same in both cases, but the perception is quite different. This metaphor can be extended to the assessment and treatment of children with a phonological impairment. In this case, the glass is the child's potential language capacity and the water is the child's current linguistic system. Different assessment approaches will in many cases generate similar results in their analyses of the child's phonetic inventories and primary error patterns, as well as in identifying targets for remediation. The similarities in the reality of a child's productions,

ABSTRACT: This paper introduces a whole-word approach to phonological analysis and then demonstrates the use of the approach by conducting an analysis and outlining treatment recommendations for a child with a phonological disability. Rationale for using a whole-word approach and also for defining phonological typologies are presented using the view that children are word oriented and use different patterns to acquire their phonological systems. New measures for word complexity and target proximity are explained, and four components of a phonological analysis are outlined and subsequently demonstrated.

KEY WORDS: phonology, disorders, children, analysis, intervention

however, need to be understood within a broader context of how the purpose of the enterprise is perceived. That is, how do we perceive the child's linguistic system?

The first goal in assessment usually is to determine if the child is acquiring language at the typical rate. If not, it often is the case that the child is perceived as someone who is lacking something (e.g., the age-appropriate inventory of consonants and vowels). The child's phonological system then is characterized as a set of errors, be it described as substitutions or phonological processes. From this perspective, remediation is a corrective process, filling in the missing pieces. It is possible, however, to take an alternative half-full approach. In this latter case, the focus is on the child and what the child is attempting to accomplish through his or her phonological productions. Assessment is framed more within determining what the child has acquired and the pattern of acquisition the child is following. The child is seen as an active learner, and the child with a phonological impairment is attempting compensatory patterns to overcome problems he or she is facing.

The half-full, or more appropriately stated, child-oriented approach leads to the identification of two aspects of assessment and remediation that will be demonstrated in this article. First, children acquire words, not individual consonants and vowels, and show little awareness of segments. We advocate a whole-word approach to assessment and remediation, building on the assumption that children are word-oriented, not segment-oriented. Second, children differ in their patterns of acquisition, and determination of the kind of phonological learning a given child is using is important. This leads to a typological approach, with the first distinction made being whether a child has a phonological delay or impairment. The presentation will proceed by first discussing each of these two aspects in more depth. These points then will be demonstrated through the analysis of 94 words produced by a child at 42 months of age, followed by implications for remediation.

THE MEASUREMENT OF WHOLE WORDS

Researchers have spent many years examining the order of acquisition of segments (individual speech sounds), particularly consonants, and their patterns of substitution. This is important research because it delineates which consonants are harder to acquire, and what errors are typical or atypical. It is likely that the articles in this forum will be in relative agreement in their analyses of consonantal acquisition. Less is known, however, about whole-word patterns of acquisition. The information thus far focuses on whole-word correctness during a single production of a given word (Bankson & Bernthal, 1990; Schmitt, Howard, & Schmitt, 1983). Schmitt et al. collected preliminary data on whole-word accuracy (WWA) using conversational samples from children between the ages of 3 and 7 years. Their results indicated a significant correlation between articulation scores on the Arizona Articulation Proficiency Scale (Fudala, 1974) and WWA, as well as a significant increase in WWA between the ages of 3 and $3^1/_2$ years. Whole-word patterns involving properties beyond complete accuracy and WWA scores for children less than 3 years of age have not been researched to any degree.

A child's words can differ from one another not only in correctness, but also in phonological complexity and intelligibility. A specific word also can be pronounced differently from one instance to another. What percentage of a child's early words are pronounced correctly at different stages of acquisition (e.g., the first 50 words, the second 50 words, etc.)? There is a significant increase in accuracy between 3 and $3^1/_2$ years of age when percentage correct jumps from 68% to 76%. Is there an earlier age when whole-word correctness increases significantly? If so, what change accounts for it? Children's words get more complex as they develop, but what is the course of this development? What is the intelligibility of typically developing children at different stages of acquisition? Is there a point where a child's intelligibility increases significantly? If so, what change accounts for it? Lastly, we know that individual phonemes are produced differently from one attempt to another (e.g., /s/ as sometimes [s] and sometimes [t]). What about whole-word variability? The same questions about whole-word correctness, complexity, and intelligibility can be asked about whole-word variation.

Ingram (2000) raised these questions and proposed some preliminary suggestions on how to measure whole-word correctness, complexity, intelligibility, and variation. Here, we will outline the nature of these measures and apply them later to the data of the child being analyzed.

The first area, whole-word *correctness*, is the easiest aspect to measure. The child's words are examined to determine if they contain errors or not. The procedure involves lining up the transcription of the child's word against what is considered the standard adult pronunciation. If there is a complete match, the word is marked correct. This is similar to the method of eliminating any words with misarticulated sounds, which was used by Schmitt et al. (1983), and the measurement of word's correct on the Bankson-Bernthal Test of Phonology (BBTOP, Bankson & Bernthal, 1990). Once the number of correct words is determined, the proportion of whole words correct (PWW) is calculated by dividing the number of whole words correct by the total sample size. For example, if a child's first 50 words contain 5 correct whole words (e.g., *no, my*), than the PWW is .10 (or 10%).

Schmitt et al. (1983) felt that norms on whole-word correctness would be useful in addition to the norms available for standardized articulation tests and other measures such as percentage of consonants correct (Shriberg & Kwiatkowski, 1982). Bankson and Bernthal (1990) subsequently included a word correct score as part of the profile on the BBTOP. A stronger adoption of whole-word measures is advocated. The current lack of use, particularly given the ease of computation, may stem from the continued brevity of knowledge. This is true especially for young children. Ingram (2000) presented some very preliminary data on whole-word correctness during the acquisition of the first 50 words. These results indicated that approximately 10% of a child's first words are completely correct. He suggested that whole-word correctness may not be the single-most important factor in phonological acquisition. Instead, he suggested that increasing complexity and intelligibility may be more important. This point will be returned to later.

The measure of whole-word *complexity* is a much more difficult task. Complexity involves many aspects of phonology such as segmental complexity (e.g., /s/ vs. /t/), syllable complexity (e.g., clusters vs. single consonants), phonotactic complexity (e.g., co-occurrence of particular segments; /st/ vs. /ts/), and the combination of all of these within a word (e.g., *bee* vs. *zucchini*). Segmental acquisition will be influenced by the increasing complexity of the words acquired (Macken, 1978). Given this, a measure that attempts to incorporate the details of all of the aspects of complexity potentially will be complex, take time to develop, and have to provide strict guidelines in order to avoid low reliability.

Ingram (2000) suggested a simple measure of whole-word complexity that is relatively easy to use and potentially highly reliable—the phonological mean length of utterance (PMLU). The name reflects that it attempts to do what mean length of utterance (MLU) does in language assessment (i.e., provide a number that increases with the child's increase in the length of his or her productions). The MLU applies to sentences, however, whereas the PMLU applies to words. The measure focuses on two aspects: (a) the number of segments in the child's word, and (b) the number of correct consonants. The number of segments captures the fact that children's words get longer as they become more complex. Scoring consonants rewards the child not only for using a consonant, but also for matching the target phoneme. Vowels correct are not scored because transcribers vary more greatly in their transcriptions of vowels (e.g., Powell, in press).

A brief description of the rules for the calculation of the PMLU is summarized in Table 1 (a more complete description and justification can be found in Ingram, 2000). The procedure is relatively simple to apply. First, each segment in the child's word is counted and given a single point. Next, an additional point is given for each correct consonant. The minimal score that a word can receive is 1, if the child only produces a vowel (e.g., [i] for *me*). Because most children produce at least a consonant vowel (CV) syllable in their first words, it is expected that the earliest scores will begin with 2 (e.g., *see* [ti]). A score of 3 can be obtained for a word either by adding a final consonant (e.g., *sock* [tat]) or by getting a consonant correct (e.g., *me* [mi]). The PMLU is calculated by adding the total number of points assigned for a selected set of words and dividing that number by the number of words. For example, if 75 points are assigned to 25 words, the PMLU will be 3.0. Given that children do get some consonants correct early on and also use final consonants relatively soon, one expects that early scores will range more between 2 and 4 points. Below are some hypothesized stages for PMLU development modeled after those proposed by Brown (1973). These stages are not supported yet by developmental data, and are listed in (1) as an example of how a child's PMLU, or complexity, may increase with age. Once normative data are available, the stages potentially could be used to compare a child's complexity to that of his or her age-matched peers. Each stage has a range of PMLU scores with midpoints that are one point apart.

Table 1. A summary of rules for the calculation of the phonological mean length of utterance.

Sample size	Select at least 25 random words.
Lexical class rule	Count words (e.g., common nouns, verbs, adjectives, prepositions, and adverbs) that are used in normal conversation between adults. This excludes child words (e.g., *mommy, daddy, tata,* etc.).
Compound rule	Do not count compounds as a single word unless they are spelled as a single word (e.g., *cowboy* but not *teddy bear*; i.e., *teddy bear* would be excluded from the count).
Variability rule	Only count a single production for each word.
Production rule	Count one point for each consonant and vowel that occurs in the child's production. Syllabic consonants receive one point (e.g., syllabic "l," "r," and "n").
Consonants correct rule	Assign one additional point for each correct consonant.

(1) Possible stages based on the PMLU

Stages	Range	Midpoint
I	2.5–3.5	3.0
II	3.5–4.5	4.0
III	4.5–5.5	5.0
IV	5.5–6.5	6.0
V	6.5–7.5	7.0
Beyond V		

Like whole-word complexity, the measurement of whole-word *intelligibility* also is a potentially difficult task. To date, most work on intelligibility involves playing words to listeners and asking them to identify the words. The standardized tasks to do this (e.g., Wilcox & Morris, 1999) are time consuming and only appropriate for more advanced children. Ingram (2000) suggested a simpler way to get at least an indirect measure of intelligibility by using a measure that examined the proximity of a child's word to the adult target. Take, for example, the data in (2), which consists of 10 children's attempts at the word "zucchini." (The data are taken from Ingram, Christensen, Veach, and Webster [1980], though hypothetical data are sufficient to demonstrate the point). For now, ignore the figures provided within parentheses.

(2) Ten productions of *zucchini*

[dzukini] (8, .89); [səkini] (8, .89); [kʊkini] (8, .89); [ðukini] (8, .89); [ʃukini] (8, .89); [skini] (7, .78); [ziŋki] (7, .78); [kini] (6, .67); [zini] (6, .67); [zəzi] (5, .56)

In terms of whole-words correctness, none of the words is correct. If we score the percentage of consonants correct, they have exactly two consonants correct. The words differ greatly, however, in their approximation to the target word. The first five words that retain three syllables are relatively close to the target and are more likely to be identified by a naive listener. This is much less likely for the last five productions. The difference between these words also can be seen through their PMLU measures, which are provided in parentheses (left side) after each word.

The degree of proximity can be captured by a measure referred to as the proportion of whole-word proximity (PWP) (or intelligibility, assuming proximity is correlated with intelligibility, a conclusion that is intuitively reasonable but yet to be proven.). The PWP is determined by calculating the PMLU of a target word first and then dividing that into the PMLU of the child's production. For example, the maximal PMLU score for the word "zucchini" [zukini] is 9 (i.e., one point each for six segments and one additional point for each of three consonants). The child who produces the form [zini] will receive a PMLU score of 6 (i.e., four segments plus two correct consonants). The PWP, then, will be .67, the proportion that results from dividing 9 into 6. The forms in (2) show the PWP scores for each word in parentheses (on right side).

The preliminary data presented in Ingram (2000) indicated that children have relatively high PWPs from the beginning of phonological acquisition. An analysis of five children in the first 50 words stage had scores all greater than .50, ranging from .53 to .74. This preliminary result suggested the possibility that, for at least some children, the driving force behind phonological acquisition is the need to maintain a relatively high proximity to the adult targets, not the acquisition of phonetic or phonemic inventories per se. Such a strategy makes sense; even at the earliest stages, children can be relatively intelligible with small phonetic inventories if they choose very simple words. This point of view turns the current view of phonological acquisition upside down. Presently, the belief is that the child's simple first words are the result of his or her simple phonetic inventories. This view, however, does nothing to restrict a child who may only produce [ba] from using it for longer words such as *bathroom, banana,* and *basketball.* In reality, it is more common that [ba] represents simpler words such as *ball* and *bath.* The need to maintain a high proximity to the adult target does account for the simpler use of [ba]. This new viewpoint on phonological acquisition has important implications for assessment and remediation that we will return to later.

The study of whole-word proximity also may explain the trade-off effects noted for many years (e.g., Ferguson & Farwell, 1975). For example, a child who produces /ʃ/ in *shoe* may simplify it to [s] in *sheep.* Examples like this are explained by the child trading off complexity by simplifying /ʃ/ so that the final [p] can be produced. The missing piece to this proposal, however, is this: Why doesn't the child simply say [ʃi] instead? A whole-word approach makes the following proposals for this example. First, the form creates a lexical problem because the form is a complete match for the word *she.* Ingram (1975) provided examples like this where children used novel phonological changes to keep potential homonyms apart (e.g., saying *plane* as [me] to keep it distinct from *play* [pe]). In the *sheep* example, *she* is a higher frequency word and this may double the child's attempt to keep it distinct from *sheep.* Second, it may be the case that the production of a final consonant contributes more to intelligibility than adding one more phonological feature to the word-initial consonant, even if it produces a correct one.

Last, we have known for some time that children are not always consistent in the way they pronounce words. Often, however, this variability in production is stated in reference to specific segments. For example, we might score a child as producing a phoneme like /s/ as correct some percentage of time, say 60%. The reality, of course, is that this variability is part of word productions. We rarely, however, measure whole-word variability. For example, if a word is produced more than once, what is the likelihood that it will be produced the same as the first instance? Also, if a child can produce a sound part of the time, why can't he or she produce it all of the time?

Whole-word *variability* is important when we consider the issue of intelligibility. We have already suggested that a key factor in a child's phonological acquisition is producing words that are intelligible, even if they are not completely correct. Suppose a child cannot produce a phoneme like /ʃ/, but consistently produces it as [s] (e.g., *ship* [sɪp]). The people who interact with the child on a regular basis will notice such correspondences and use them to interpret new productions (e.g., [su] in the context of putting on a shoe). A child who is not consistent in his or her productions, however, will not be as intelligible. This situation, in fact, has been proposed as one of the properties of a child with a phonological impairment (Grunwell, 1981).

Most articulation tests elicit only one production of each word so that whole-word variability is not even considered in the analysis of the child's system. This is the case for the data discussed later. We are unable to say, therefore, whether whole-word variability is a property of this child's phonology or not. The importance of whole-word variability, however, is illustrated in a recent study by McCartney (2000). McCartney compared whole-word variability in a group of normally developing children with a group of children with cochlear implants. The children produced a set of words that all began with fricatives and affricates three times each. The two groups were matched on their percentages of correct word-initial fricatives and affricates. McCartney found that whole-word variability decreased for the typically developing children as their scores for fricatives and affricates correct increased. This decrease did not occur for the children with cochlear implants. It is known that children with cochlear implants have low intelligibility even when their consonants correct scores are high (Tobey, 1993). McCartney concluded that whole-word variability is the reason for this.

In summary, we propose that the goal of phonological acquisition is to achieve word productions that will be in close proximity to and eventually match the adult target vocabulary. The purpose of assessment then becomes the analysis of how successful a child is at achieving this by the use of measures of whole-word production. Children who have low PWPs and high proportions of whole-word variability will be largely unintelligible and are likely candidates for identification as having a phonological impairment. Remediation will be geared toward whole-word goals, not just goals to achieve the production of individual segments within meaningful words.

THE TYPOLOGY OF PHONOLOGICAL ACQUISITION

Children do not always follow the same course of phonological acquisition. Despite attempts to capture how individual children differ concerning their phonological acquisition (e.g., Lléo 1996, Macken 1978), it is still common to apply developmental norms—norms that are based predominantly on what consonants can be produced correctly at what ages (e.g., Templin, 1957). Such a practice assumes homogeneity among children. A further practice is to identify children as consisting of two groups—those who are typically developing and those who have a language impairment. The latter distinction has a practical motivation (i.e., it determines which children will qualify for services and which will not). That reality, however, is independent of our need to understand the course of phonological acquisition.

Ingram (1987, 1997) proposed that a typology of phonological acquisition that encompasses all children is needed. At this point in time, the first step needs to be a descriptive typology, that is, to identify the distinct patterns of phonological production found among subtypes of children (cf. Dinnsen, 1992 and Shriberg, 1998 for alternative efforts to develop linguistic and etiological typologies respectively). Such a descriptive typology is prerequisite for a more insightful theoretical account. A descriptive approach will need to consider two primary aspects of acquisition—the rate of word acquisition and the nature of the child's phonological system. We will address each in turn.

Phonological assessment does not commonly focus on the nature of the child's vocabulary. It is the case that vocabulary tests are given as part of phonological assessment, with the purpose to determine if the child's receptive vocabulary is age-appropriate. However, expressive vocabulary rarely is measured because of its inherent difficulty in portraying a given child's abilities accurately without requiring considerable time and effort on the part of the clinician. What phonological characteristics, however, should be expected in relation to vocabulary development? There are three relationships that might be found. One would be if the child's phonology were in advance of his or her vocabulary. If such were the case, we would expect the child's intelligibility to be high. Such a child likely would not be a candidate for identification as having a phonological impairment, though language impairment would not be ruled out. A second relationship would be if the child was in a typical relationship. The most knowledge we have on this relation is during the acquisition of the first 50 words. Research has revealed that certain phonetic inventories and syllable structures are common during this early stage of acquisition (Ingram, 1981; Stoel-Gammon, 1985). A child with this relationship between vocabulary and phonology would be considered typically developing if his or her vocabulary was within an acceptable range for normal development. However, if a reduced vocabulary is suspected and phonology is below age-matched peers, the child may be a candidate for *language delay.* It should be anticipated in a normal distribution that a small number of children would fall into this category. It also should be noted that the children who do fit this typology are ones who need to have their receptive and expressive language assessed carefully to see whether an overall language delay is present. Third, a child could have a phonological system that is behind in relation to his or her vocabulary growth. This child would be a candidate for *phonological delay,* and the severity of the impairment would be the extent to which the phonology is lagging behind (Ingram, 1997).

Second, a typological approach of phonological acquisition focuses on the nature of the child's actual system. One basic distinction of this kind is between children with articulatory impairment versus children with phonological impairment. *Articulatory impairment* involves low-level phonetic patterns that are not precise enough to be considered correct, yet do not influence dramatically the perception of the child's phonemes. Lisping, for example, would be such a condition. *Phonological impairment,* however, involves phonological mergers and shifts (collapse and exchange of features that result in a different phoneme being produced) such that intelligibility is impaired significantly. The child who changes /ʃ/ to [s] will produce words like *she* as *see* and produce speech that will be relatively unintelligible to an unfamiliar speaker.

A typology of phonological delay has not been established yet. Also, it is likely that many if not all categories found may just be persisting patterns found in younger children. Ingram (1987) proposed the hypothesis of phonological deviance to capture how the extent of a child's phonological impairment is perceived. The more there is an inverse relationship between a child's phonological level of development and the size of his or her vocabulary, the greater the impairment. A child who changes /b/ to [m] during the acquisition of his or her first words is perceived as producing a substitution that is found mostly at the earliest stages of acquisition. The 4-year-old with a vocabulary comparable to his or her peers who makes this substitution is seen as highly impaired.

There is another effect of a persisting early pattern that Grunwell (1981) labeled *gross inclusion.* This is the circumstance where a substitution pattern extends across a wide range of contexts. For example, a child during the acquisition of his or her first words may for a time replace fricatives with stops (e.g., [t] for /s/). Such a pattern may affect only a small number of words, given the child's small vocabulary and the tendency for younger children to avoid using words with which they have problems (Schwartz & Leonard, 1982). The persistence of the pattern, however, across a consistently increasing lexicon might end up as [t] for /θ/, /s/, /ʃ/, /tʃ/, and even the voiced fricatives in some instances.

It also is the case that some children go beyond using persisting phonological patterns to produce unique or atypical patterns (Leonard, 1985). Such patterns may include using sounds that are not part of the phonetic inventory of English, such as bilabial fricatives, nasal snorts, and lateral fricatives. Some cases may involve using a syllabic template for all words (Leonard & Brown, 1984). An unusual case of this kind is reported in Ingram and Terselic (1983). The child in question produced voiceless alveolar fricatives, /s/, as an ingressive sound (i.e., he breathed air inward for this sound rather than outward). Also, to produce the sound, he needed to do so in the final (coda) position of the syllable. This resulted in some very unusual productions when the target /s/ was in the initial (onset) position of the syllable (e.g., the ingressive "s" is shown as [s↓]); *sunglasses* [wɑɪs↓+wæs↓ɪs↓], *soap* [wʌs↓p], *basket* [bæs↓ɛ]).

The question arises why a child would produce exceptional patterns like this. Ingram (1997) suggested that these productions need to be viewed as compensatory patterns, or excessive efforts to overcome the current persistent pattern. The production of an ingressive "s" or a nasal snort for a fricative sounds more like a fricative than a stop substitution. Such an interpretation is consistent with the main theme of the present article to focus on what the child has rather than on what is lacking. In fact, such patterns may be potentially positive indicators because they indicate that the child is working hard to overcome his or her error patterns. The child with the ingressive "s" dropped the pattern after several weeks of phonological intervention.

Another issue is whether or not there are particular subgroups of children with phonological delay who show consistent phonological patterns that are not as common as those used by younger children. Probably the most common pattern is one where a child's inventory is developmentally unusual because it is lacking any fricatives and affricates. Research on the inventories of young children developing typically has shown that at least [f] and [s] are found during the acquisition of the first 50 words (Ingram, 1981; Stoel-Gammon, 1985). A case of a pattern where the fricatives and affricates are missing is Matthew, from Maxwell and Weismer (1982), whose initial consonant patterns are displayed in (3). (The child's consonants are displayed within square brackets [ ] and the target sounds are shown next to each in virgules / /). Note also that Matthew provides a good example in his use of [d] of gross inclusion referred to above.

(3) Matthew

[m] /m/	[n] /n
[b] /b,p,f,v/	[d] /t,k,d,g,dʒ,tʃ,ʃ,s,θ,z/
[w] /w/	[j] /j/

Renfrew (1966) identified another pattern of phonological impairment that she called the *persistence of open syllables.* This is the situation where the word-initial consonant productions are relatively advanced in relation to the final consonants, which are uniformly missing. There also are a small number of apparently rare cases where final consonant production is better than initial consonant production. We know very little as to why children would have such an asymmetry in their consonant acquisition by word position.

Ingram (1997) proposed another potential subgroup of children with phonological impairment who use voicing distinctions more excessively than is found in typically developing children. Typically developing children will often acquire three place distinctions before any voice distinctions (e.g., [b], [d], and [g], but no use of [p], [t], or [k]). The subgroup proposed by Ingram showed the opposite: the acquisition of one or more voice distinctions (e.g., [d] vs. [t]) before the acquisition of a third place distinction. The phonological inventories of initial consonants for two children are shown in (4); one typically developing, Jennika (Ingram, 1985), and one with phonological delay, a 6-year-old boy named John (Shriberg & Kwiatkowski, 1979).

(4)

Jennika		John	
[m] /m/	[n] /n/	[m] /m/	[n] /n/
[b] /b,p/	[d] /d,t/ [g] /g/	[b] /b/	[d] /d,g,θ/
[f] /f/	[ʃ] /s,ʃ/		[t] /p,t,k,s/
[w] /w,r,l/		[w] /w,l,r/	[h] /f,h/

Although the phonological inventories are similar in size, they are involved in very different phonological oppositions. Jennika shows the three place distinctions (labial, alveolar, and velar) and two fricatives (labial and coronal), but no voice distinctions. John, on the other hand, lacks a place distinction (velar) or fricatives (ignoring [h] which is made at the larynx), but has a voice distinction between [d] and [t] that contrasts seven target phonemes, and a voice distinction between [w] and [h] that targets five more target phonemes. Also, the use of [h] provides a voice contrast between words beginning with a vowel (a voiced segment) and those beginning with [h], a voiceless segment. As with the discussion of atypical patterns, we propose that the "voicing" preference is the result of compensatory patterns. A child who may be having problems with place of articulation may rely more heavily on voice distinctions to achieve some success in his or her word forms.

In summary, children will show a range of patterns of phonological acquisition, and a taxonomy is needed in order to delineate these patterns. Determining any particular child's individual type will be a major step toward understanding his or her phonological system and planning intervention. The taxonomy needs to include information about the child's linguistic and lexical acquisition, as well as his or her phonology. It also should identify what unique compensatory patterns a child may be using. Table 2 provides a summary of the typology developed in this section.

PHONOLOGICAL ANALYSIS

The four components listed in (5) will be described and used subsequently to provide an analysis of the data

Table 2. A preliminary descriptive taxonomy of phonological acquisition.

1. The phonologically precocious child: The child's phonological system is in advance of his or her language and vocabulary development; the child's speech is characterized by unusually high intelligibility.
2. The typically developing child: The child's phonological system in most general characteristics is consistent with what would be expected for a child with his or her linguistic and lexical knowledge; if this is in advance of expectations, the child is linguistically precocious; if this is age-appropriate, the child is described as typically developing; if this not age-appropriate, the child is language delayed.
3. The phonologically delayed child: The child's phonological system is behind his or her linguistic and lexical knowledge; the greater the discrepancy, the greater the perception of impairment. The child's phonological system may be characterized by one or more of the following properties.
    a. Developmentally appropriate: The child may show patterns of phonological acquisition that are consistent with those found in younger children.
    b. Gross inclusion: Errors patterns may be typical, but they extend across a greater range of contexts than found in younger children.
    c. Uniqueness: The child may demonstrate one or more atypical error patterns; these are hypothesized to result from the child's effort to compensate for his or her persistent errors. One pattern of uniqueness is the lack of fricatives and affricates relative to the rest of the phonetic inventory; another is the advanced use of voice distinctions over place distinctions.

described in the prologue to this clinical forum (Barlow, this issue).

(5) Components to phonological analysis
  a. Whole-word analysis
  b. Word shape analysis (syllables)
  c. Segmental analysis (matches and substitutions)
  d. Phonological analysis

The first three components reflect a hierarchical approach to the data, moving from words to syllables to segments. The fourth component is the interpretative part in which we select a theoretical approach and interpret the data in its light (cf. Ball & Kent, 1997).

Whole-Word Analysis

The whole-word analysis examines the four aspects described earlier (i.e., whole-word correctness, complexity, proximity, and variability). Whole-word correctness is determined by identifying the number of whole words correct and dividing that number by the total number of words to get the PWW. The analysis of complexity and proximity involves the calculation of the PMLU for both the words produced by the child and the target words. The child's PMLU is calculated by the rules in Table 1 and the result is compared to the stages given in (1). The target word's PMLU is calculated to give an idea of the complexity of the words being attempted. In the present case, it will give us some idea of the complexity of the words used in the BBTOP. The degree of proximity (indirectly intelligibility) is determined by dividing the child's PMLU by the target word's PMLU to get the PWP. In the present instance, we will not examine whole-word variability because the child was asked to produce each word only once. The measurement of whole-word variability involves the use of a task where the child systematically repeats words (cf. discussion in Ingram, 2000).

Word Shape Analysis

The word shape analysis involves determining the most frequent syllabic patterns in the child's words and how well the child does in maintaining the number of syllables in target words. Word shapes are best studied from words taken from a spontaneous sample because they more directly reflect a child's preferred usage. The first observation to make is whether the child uses primarily monosyllabic or multisyllabic forms. Once that is determined, then the most commonly used monosyllabic and multisyllabic shapes are established. These measurements can be simple proportions (e.g., proportion of monosyllabic words out of the total number of words, proportion of CVCs out of total number of monosyllables). It is expected that the most basic syllable shapes will be found (i.e., monosyllables CV and CVC, disyllables CVCV and CVCVC). High use of these basic shapes indicates limited syllable structures; low rates suggest the opposite. The syllable analysis provides a preliminary insight into aspects such as final consonant production and clusters. The syllable analysis also provides information that will be used later to construct target words for remediation. Articulation tests restrict the value of the syllable analysis somewhat because they use a predetermined set of words rather than ones that are part of the child's everyday vocabulary. They also may elicit an excessive number of words with either monosyllabic or multisyllabic forms and more complex syllable shapes.

Besides examining the syllable shapes used, the word shape analysis also considers the number of syllables in the child's words as compared to those in the target words. This analysis determines whether or not syllable deletion is a problem for the child. Syllable maintenance can be measured by a simple proportion of the number of words that retain the same number of syllables as the targets, calculated separately for disyllables and trisyllables.

Segmental Analysis

After the syllable analysis, an analysis of the child's segments (i.e., consonants and vowels) and how they combine is completed. In this case, the examiner is concerned both with those sounds that are used correctly (*matches*) and what *substitutions* are used when they are not correct. The amount of segmental analysis that can be performed varies tremendously. The simplest analyses will score the articulation test and come up with some measure of consonants correct and possibly a list of common errors. One also might construct an inventory of correct consonants, ignoring syllable and word position. At the other extreme, one can perform detailed analyses of consonants and vowels, distinguishing between different syllable positions (e.g., word initial vs. syllable initial, stressed syllable vs. unstressed syllable), and seek out a detailed set of phonological processes (e.g., Grunwell, 1985; Ingram, 1981). Such detailed analyses, however, are impractical because they are time-consuming and may provide more information than needed to construct a remediation program.

A quick scan of the data, as proposed by Bernhardt (2000), will be a guide to the kind of segmental analysis required. Typically, vowel productions are better than consonant productions and may be eliminated from the analysis. Pervasive vowel errors, however, will require their inclusion. The fact that the child has been referred for diagnosis indicates the likelihood of consonant errors. Two factors are important for consonant analysis—word position and consonant frequency. The consonant analysis will provide information on the consonants and the major substitutions for word-initial, word-medial, and word-final positions. Medial position is defined simply as those consonants occurring between vowels. As argued in Ingram (1981), a frequency criterion also is used. This eliminates the inclusion of the acquisition of a consonant or a pattern of substitution on the basis of one instance.

There are two simple measures that jointly assist in making these judgments. The first is to require at least two instances of a pattern before it is included in the analysis (e.g., /k/ is produced correctly both times it was attempted, or [t] is a substitute for /s/ if it was produced for /s/ both times it was attempted). The second is that a pattern must have a rate of more than 50% to be included. For example, /k/ is considered correctly used if it was correct more than 50% of the time. If not, one then looks for a common substitution. If [t] was used for /k/ three times, and /g/ was used once, [t] is then the substitution for /k/ because it represented more than 50% of the errors. The results of the matches and substitutions are laid out in the form of a chart for each word position, as was done in (3) and (4) earlier. Sounds that do not meet the frequency criterion are not included; however, a note of their occurrence is made because they may represent sounds in the process of being acquired and be stimulable.

Phonological Analysis

The last step in the analysis is the phonological analysis (i.e., the attempt to capture the nature of the child's phonological knowledge). This is where many analyses differ because the range of available theories is extensive (cf. Ball & Kent, 1997). As argued in Ingram (1997), however, the different theoretical interpretations often will lead to similar intervention goals. For example, the child who substitutes [g] for /k/ needs to acquire /k/, regardless of how theories describe the substitution. Our theoretical orientation is what might be called a traditional generative phonology approach. It assumes that children are acquiring contrasts (e.g., /k/ vs. /g/) and that the contrasts are the result of the acquisition of distinctive features (e.g., [voice]). The matches and substitution analysis thus are interpreted by establishing the number of minimal contrasts that are acquired (i.e., those that differ by a single feature), and the featural contrasts that are acquired. A feature analysis requires a decision about the feature system that is used. For clinical purposes, an informal articulatory system and feature analysis is used because the purpose is just to identify the features the child has acquired in order to build his or her phonological system. The system used is adapted from Dinnsen (1992), as his proposal not only facilitates an outline of the featural inventories the child has, but also presents an order of feature acquisition. Laying out the features roughly in their order of acquisition helps to determine for any one child if his or her feature acquisition is consistent with that of typically developing children. It should be noted, however, that the current analysis does not group inventories into the levels outlined by Dinnsen.

This kind of analysis can be demonstrated with the consonantal systems given for Matthew, Jennika, and John in (3) and (4), respectively. In doing these analyses, certain decisions need to be made concerning what a contrast is and what features are behind certain ones. The segment [h] in particular is difficult because there is no strong agreement on how it should be captured within feature systems. For John, it was treated as a voiceless segment. The features that were determined to be in use by each child, and the contrasts that they capture, are shown in (6).

(6) Three feature systems for word-initial consonants

	Matthew	John	Jennika
SONORANT:	[m] [b]; [n] [d]	[m] [b]; [n] [d]	[m] [b]; [n] [d]
CONSONANTAL:	[b] [w]; [d] [j]	[b] [w]	[b] [w]
LABIAL:	[m] [n]; [b] [d]; [w] [j]	[m] [n]; [b] [d]	[m] [n]; [b] [d]; [f] [ʃ]
DORSAL:			[d] [g]
VOICE:		[d] [t]	
CONTINUANT:			[b] [f]; [d] [ʃ]

The feature analysis allows us to see how many features are being used and for which contrasts. Matthew has the fewest features, and is relying heavily on the [LABIAL] distinction. John has one more feature than Matthew, and is using [VOICE] as already discussed. Jennika's system lacks the voice feature, but has more use of the place features and the [CONTINUANT] feature that underlies her two fricatives.

PHONOLOGICAL ANALYSIS RESULTS

This section will apply the four components of a phonological analysis to John, the 42-month-old boy described in the prologue (Barlow, this issue). This child is a different one from the child reported on previously in (4) and (6), who was also named John. The analysis is based on 80 words that were produced using the BBTOP plus 14 additional words so as to allow for three occurrences of each phoneme in initial and final positions.

Whole-Word Analysis

The analysis of whole words correct revealed that John produced only one word that was completely correct *(gate).* In addition to *gate,* his production of *potato* could be considered correct as a singular form, though the elicited form was "potatoes," with the child's production missing the final fricative. Even counting both words, this result indicated that John had only 2% of his words completely correct. The results of the PMLU analysis are displayed in Table 3, where the child's words were analyzed in blocks of 25. Analyzing in blocks was done to examine John's consistency in proximity across the sample, paying close attention to changes when the target PMLU increased in

Table 3. Phonological mean length of utterance (PMLU) scores for John's productions.

	PMLU		
Words	*Adult words*	*John's words*	*PWP*
1 to 25	5.76	3.64	.63
26 to 50	7.44	5.00	.67
51 to 75	5.60	3.00	.54
76 to 94	5.89	3.73	.63
Mean	6.19	3.85	.62

Note. PWP = proportion of whole-word proximity.

complexity. The overall score was 3.85, revealing that the complexity of his words is greater than that found for children acquiring their first 50 words, but it is only at the next level of complexity. His words typically consist of either four segments or three segments with one correct consonant. The PWP, also provided in Table 3, is .62 or 62%. This figure is slightly lower than the results for typically developing children during the acquisition of their first 50 words (Ingram, 2000). It suggests that the child is doing a reasonably good job at approximating his target forms. It was particularly interesting to see how his PWP increased with the complexity of the words attempted. His PWP reached .67, or 67%, when the words attempted were the most complex. This finding suggests that we can challenge him in his treatment plan with more complex forms with the expectation that he will adjust his productions accordingly.

Word Shape Analysis (Syllables)

In analyzing John's syllables, a decision needs to be made concerning how to analyze the forms where a consonant has been replaced with a vowel, as in *seal* [ioʊ]. The vocalization of a consonant was treated as the addition of a syllable. Thus, *seal* would be a disyllabic VV form. With that decided, Table 4 presents the results of the word shape analysis. Nearly three quarters of John's words (.70) are monosyllabic, and five word shapes capture 82% of his productions. The shapes are, in decreasing frequency, CVʔ, CV, CVC, CVCV, and CVV. There are two striking features of this result—the lack of final consonants and the lack of consonant clusters. Scanning the CVC forms also revealed that John was predominantly producing [n] as his only frequent final consonant. The results of the word shape analysis indicate that potential goals for intervention will be final consonants, clusters in monosyllables, and expanding the range of word shapes using sounds he has acquired already.

Concerning syllable maintenance, John retained the appropriate number of syllables in 93% of disyllables (14 out of 15), but in only 38% (3 out of 8) of trisyllables. This striking difference indicated that disyllable structures are part of his phonological system, but longer ones are not.

Table 4. Results of John's word shape analysis.

Word shapes	*Number*	*Proportion*
Monosyllables	66	.70
CVʔ	25	
CV	21	
CVC	14	
Other	5	
Disyllables	25	.27
CVCV	11	
CVV	6	
Other	8	
Trisyllables	3	.03

Segment Analysis (Matches and Substitutions)

John's word-initial, -medial, and -final consonants were analyzed for matches and substitutions. A frequency criterion of 2 was used (i.e., matches and substitutions were only considered if they occurred at least twice). Also, the match or pattern of substitution needed to occur more than 50% of the time in order to be considered (e.g., /k/ produced as [t] three times, and [k] one time is counted as a [t] substitution because it occurred for 75% of the attempts). The results of the analysis for word-initial and word-final positions is provided in (7). The analysis of medial consonants will be presented separately.

(7) Word-initial consonants

[m] /m/	[n] /n/	
[b] /b,p,v,f/	[d] /d,t,s,θ,ð,dʒ/	[g] /k,g/
	[t] /ʃ,tʃ/	
[w] /w,r/	[j] /j/	
	[l]	
		[h] /h/

Word-final consonants

[n] /m,n/
[ʔ] /p,t,k,f,θ,s,ʃ,tʃ/
deletion of /v,dʒ,b,d,g/
vowels replace /r,l/

The analysis of word-initial consonants indicated that John was using 10 segments, a larger number than we saw in the samples discussed earlier. There were three places of articulation for the voiced stops, a pattern found in typically developing younger children. In addition, there were very few voice distinctions, so John was acquiring place ahead of voice. There were, however, three properties of this system that made it look impaired. First, there was gross inclusion for [d], which was being used for a wide range of coronal obstruents. Second, the system had a peculiar substitution pattern for [t], which was being used only for voiceless palatal sibilants. Third, the phonemic inventory included /l/, a phoneme that normally is acquired after voice and continuant contrasts have been established (Dinnsen, 1992).

Turning to final consonants, only /n/ had been acquired, and it was used as a substitute for /m/. Voiced obstruents were deleted, and voiceless obstruents were replaced by a glottal stop. Liquids were changed into vowels. If glottal replacement was collapsed with the deletions, there would be an extensive gross inclusion for missing consonants.

In general, the analysis of medial consonants is not always very revealing. This may be the case if the child treats medial consonants as word-initial consonants, so that they can be combined with word-initial consonants under the classification of syllable-initial consonants. Also, patterns of medial consonant use may be harder to see because they may be lower in frequency than either word-initial or word-final consonants. There are, however, at least two instances in which medial-consonant analyses are insightful. First, it may be the case that the child treats medial consonants distinctly from either word-initial or word-final consonants. This might be the case, for example, for a child who uses a glottal stop for intervocalic consonants that otherwise appear in the other position (e.g., *paper* [peʔ√], *basket* [bæʔɛt]). The second instance is a case like the present one, where a child deletes final consonants. Medial-consonant analysis will indicate whether a consonant that is deleted in word-final position will surface in word-medial position (e.g., *dog* [da], *doggie* [dagi]). This will provide insight into the nature of the child's system, suggesting that the child knows that a final consonant should be there. This situation can be contrasted to the one where a child drops the final consonant throughout (i.e., *dog* [da], *doggie* [dai]). Gierut, Elbert, and Dinnsen (1987) proposed that the latter case is because the child has not represented the final consonant in his or her underlying representation, whereas the former one is because there is a constraint on final consonant production.

The analysis of the medial consonants revealed that the ones that occurred were a subset of the word-initial consonants. The consonants [b], [d], [g], and [w] occurred at least twice in word-medial position, and [m], [n], and [l] occurred at least once. These sounds constituted a subset of the ones used in word-initial position. Because there were no pairs of words such as *dog* versus *doggie,* it was not possible to determine whether John would delete or retain the [g] in *doggie.*

In summary, John's segment analysis indicated that his system was a combination of patterns that were typical looking and those associated with impairment. His acquisition of nasals, voiced stops, and glides was typical of younger children. The use of consonants in word-initial and word-medial positions was similar, suggesting that the child was using the categorization of syllable-initial (onset) position. The system looked impaired, however, by its lack of fricatives and affricates, final consonants, instances of gross inclusion, and comparatively early acquisition of /l/.

Phonological Analysis

The feature analysis focused on word-initial consonants because these constituted the main inventory of John's consonants. The features proposed along with the minimal contrasts involved are listed in (8). The features were ordered in the same sequence as done earlier in (6).

(8) John's features

SONORANT:	[m] [b]; [n] [d]
CONSONANTAL:	[m] [w]; [n] [j]
LABIAL:	[m] [n]; [b] [d]; [w] [j]
DORSAL:	[d] [g]
VOICE:	possibly [h] versus vocalic onset
CONTINUANT:	
NASAL:	[l] [n]

The feature analysis captured the fact that place features were being acquired before voice, and that fricatives were missing. It also showed the early use of nasal that distinguished lateral [l] from other segments that are sonorant (e.g., [n]).

TREATMENT GOALS

A well-developed analytic approach will translate directly into a set of treatment goals. For example, a decision to analyze for phonological processes will result in a treatment program with targeted phonological processes. The analysis plan followed for this child involved four components, as outlined in (5). Table 5 presents these and possible treatment goals that result from our analysis.

The use of whole-word analyses introduced another dimension to phonological intervention. Typically, the focus was to identify target sounds and work on the notion of expanding the phonological repertoire, and some proposals

Table 5. Analysis results and possible treatment goals based on John's productions.

Component	*Analysis results*	*Treatment goals*
Whole words	Few whole words correct PMLU: Stage II 3.85 PWP: over 50%	Increase whole-word correctness Increase to Stage III Use words with 5.5 to 8.0 PMLUs
Word shapes	CV, CVC, CVCV	Use preferred shapes for new sounds Use old sounds for new syllables
	Preserves disyllables	Use CVCV for final consonants Adding diminutives and "ing"
Segments		
Word initial	[m,n,b,d,g,t,w,j,l,h]	Use for whole-word correctness Target voiceless stops, fricatives, and clusters
Word final	[n]	Target final consonants
Word medial	similar to word initial	Use for word-initial targets and final consonants
Phonology	[sonorant], [consonantal] [labial], [dorsal], [nasal]	Introduce [voice], [continuant]

along these lines will be made as well. There was, however, also the option of making use of the phonological patterns the child already had to expand his intelligibility. If it is assumed that a child with a phonological delay has some awareness that his speech is not understood easily, it is intuitively sensible to believe that increased understanding should be highly motivating. This can be done by developing interactions in which the child uses words that are either correct or close to being so.

Theoretically, a focus on maximizing intelligibility and using segments within the child's current system seemed to be the antithesis of current efficacy research advocating the choice of targets that create the greatest system-wide change (Gierut, 1992). Within a whole-word approach, however, the actual targets selected can follow a developmental model, as illustrated, or a maximal opposition model, in which a restricted number of phonemes that currently are not in the system are chosen. Maximal opposition espouses the concept of deep training (cf. Elbert & Gierut, 1986) to select a restricted number of targets that are in contrast. Using this method of target selection within a whole-word approach would be difficult but not impossible. Using a developmental model allows one to train a broad number of phonemes that collectively represent features the child is lacking (e.g., [f], [v], [s], [z], to target continuant). This, in turn, allows the clinician to pick from a wider selection of target words that the child can approximate and that also are within the child's vocabulary. Regardless of the model used to pick targets, the focus is on increasing intelligibility within a natural context rather than on forcing the reorganization of the system through minimal or maximal contrasts. The concept of using intelligibility as the underlying motive for change has been employed extensively and successfully at the phoneme level (i.e., contrasts in minimal and maximal pairs result in a meaningful difference that affects the child-clinician interaction). A whole-word approach takes the emphasis off of the minimal unit of change (phoneme) and puts more emphasis on whole-word production and inner motivation to match the adult target. Whether this results in efficacious therapy remains to be seen.

The whole-word analysis revealed that John rarely produced whole words correctly, yet approximated the target words in the 60% range. One component of the treatment plan involves using the sounds John already has to increase the use of words that are correct or close to being so. Here are some examples of words that John would likely know that meet this criterion: ***animal terms:*** *bee, bunny, hen, lamb;* ***food:*** *banana, bean, donut, dinner;* ***toys:*** *ball, bat, doll;* ***clothing:*** *boot, button, diaper;* ***body parts:*** *eye, hair, hand, knee;* ***household items:*** *bottle, bowl, hammer, money;* ***miscellaneous nominals:*** *ladder, moon, rain, rock, wind, water, home;* ***verbs:*** *go, do, give, get, gonna, eat, bite, buy, dump, hear, wait, run;* ***inflected verbs:*** *hugging, building, hiding, holding, reading, riding, running;* ***miscellaneous:*** *no, nightnight, hello, down, wet.* The suggestion is that the beginning of each session would be devoted to structured stories or dialogues that would be focused on having John communicate with highly intelligible words to someone unfamiliar with his speech.

After this initial work on intelligibility and whole-word correctness, the session would turn to the more common practice of introducing new sound patterns into John's phonological system. The segmental analysis clearly identified the following areas to work on: voiceless stops, final consonant production, fricatives and affricates, consonant clusters, and trisyllabic words. Even here, though, the results of the whole-word analysis can guide the selection of target words. New segments can be introduced in words that involve syllable shapes that John prefers, such as CV, CVC, and CVCV, and which consist entirely of segments that are already in John's inventory. The complexity of target words can be measured by the PMLU so that John can still maintain his proximity measure at greater than 60%. An example of an acceptable target is *can,* because John's substitution of [g] for /k/ would result still in a PWP of .80 (1 point for each segment and an additional point for the correct final consonant would result in a PWP of 4/5, or .80). Some examples of words that both meet and do not meet this guideline for voiceless stops, using the proportion of proximity measure, are listed in (9).

(9) Potential target words for voiceless stops
    Yes: *can* (.80), *key* (.67), *table* (.71), *pen* (.80), *toy* (.67), *tummy* (.83)
    No: *cup* (.40), *kangaroo* (.36), *pencil* (.55), *tickle* (.57), *peach* (.33)

Maintenance of proximity at greater than 60% also can guide potential target words for fricatives, final consonants, and consonant clusters. Additionally, targets can be selected using a maximal opposition model (e.g., [r] and [tʃ], which differ by the major class feature sonorant and by six additional features). This, however, limits the naturalness, or functionality, of the words chosen. The following is a list of word pairs that meet the proximity guidelines for [r] and [tʃ]; *beach, beer, batch, bear, match, mare, witch* and *wear.* Choosing contrasts that are not maximal, but still vary by several features, broadens the target words that may be used (e.g., *fan, ran; sun, run; show, row*). Longer words with three syllables that contain sounds John already has can be introduced. For example, *banana* and *lullaby* potentially have a PWP of .67 because a CVCV production of each would still contain consonants he has. This is not the case for other words such as *butterfly* and *elephant* that would have syllable reduction and consonantal substitutions because they contain sounds he has not acquired yet. A goal for increasing syllable length that attempts to keep a high PWP will, however, severely restrict the number of target words that are commensurate with John's vocabulary. It is more functional (i.e., would further increase John's use of intelligible words) to focus on establishing a greater inventory and a firmer use of closed syllables before expanding the actual number of syllables.

Although clinicians intuitively follow the practice of using a child's current system to establish targets, the PWP provides a more explicit guideline for such decisions. In addition, the PWP measure can be used to set benchmarks when written goals need to conform to a behavioral format

Table 6. Proximity-driven treatment goals for John.

1. John will produce 10 target words with an average PWP score of .8 or higher using his current phonological and word shape inventory.
   Today's session: *boy, bunny, lamb, hair, wool, barn, eat, hop, run, hay*
2. John will produce voiceless stops (fricatives and consonant clusters) with 70% accuracy in the context of words that are currently produced with a PWP of .60 or higher.
   Voiceless targets: *pen, pie, two, ten, toy, cow, can*
   Fricative [continuant] only targets: *zoo, van, busy, dizzy, heavy*
   Fricative [continuant] and voiceless *targets: sun, so, see, fun, shoe, shy and FEE FIE FOE FUM*
   Consonant cluster targets: *blue, brown, gray, green, glue, glow, draw*
3. John will produce 5 closed syllable words (CVC and CVCVC) with a PWP of .80 or higher using only phonemes currently in his initial phonological inventory.
   Targets: *dad, mom, bag, bob, won, ham, dog, melon, lemon*

Note. PWP = proportion of whole-word proximity.

that requires a do, condition, and criteria (e.g., Roth & Worthington, 1996). Table 6 illustrates three behavioral goals that target increased proximity (or intelligibility), use of a specific segment or feature, and use of closed syllable words while using John's current system to promote success.

In summary, we propose a treatment plan that would include both a focus on using the system John already has acquired to develop his intelligibility and to provide a framework for future gains in the use of final consonants, fricatives, and consonant clusters. The complexity of selected target words is assessed so that new sounds are introduced in words within his system. The expansion of his syllable shapes conversely would involve the sounds he has acquired already. Throughout, the assessment of his phonology would involve not only the expansion of the phonological system, but also the increase in his overall word complexity and its relationship to the complexity of the words attempted.

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