THE EFFECTS OF PHONOLOGICAL INTERVENTION ON MORPHOSYNTACTIC DEVELOPMENT IN PRESCHOOL CHILDREN WITH PHONOLOGICAL AND MORPHOSYNTACTIC DISORDERS

by

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ABSTRACT

This study examines the effects of direct (nonlinear) phonological intervention on phonological and morphosyntactic development for children severely impaired in both domains. Subjects were 9 children aged 3 to 4 years. Seven had severe phonological and morphosyntactic production disorders (treatment group) and two had only a severe phonological disorder (control reference subjects). Phonological measures used were Percentage Consonants Correct (PCC), plus nonlinear word shape and feature analyses. Language observations used were MLU, Index of Productive Syntax (IPSyn), Brown's stages, morphological analysis and Mean Length of Longest Utterance (MLUL). Results indicate an influence of phonological intervention on morphosyntactic development for the subjects with both disorders. All subjects improved on their phonological measures. On the language measures, only those with severe disorders in both domains displayed notable improvement. Targeting the phonological domain in therapy may be a cost-effective way to conduct treatment for at least some children with severe phonological and morphosyntactic production impairments.

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CHAPTER ONE

INTRODUCTION

The Link Between Phonological and Morphosyntactic Impairments

There is evidence of a developmental relationship between phonology and syntax. Past research has demonstrated this for children with both phonological and morphosyntactic disorders (Panagos, 1982; Schwartz et al., 1980; Prelock & Panagos, 1989; Donahue, 1986; Crystal, 1987; Leonard, 1982; Aram & Kamhi, 1982; Panagos et al., 1979; Menyuk & Looney, 1972; Dubois & Bernthal, 1978). Tyler and Watterson (1991) estimate that up to 75-80% of children with phonological disorders have associated morphosyntactic impairment, and that phonological and syntactic disorders appear to co-occur in about 60-80% of children based on studies by Shriberg et. al (1986), Shriberg and Kwiatkowski (1988), and Tyler and Edwards (1986). Recently, Fey et al. (1994) found that up to 90% of their morphosyntactically impaired subjects also had phonological impairments that were judged to be at least moderate in severity. Given the frequent co-occurrence of these disorders, it is surprising to find that the nature of their relationship and implications for intervention with children impaired in phonology and syntax remain unclear (Fey et. al., 1994). Clinicians continue to face the decision of whether to focus intervention on phonology, morphosyntax, or both linguistic domains simultaneously. The answer to this question lies in understanding the relationship between the two linguistic domains. If the two domains do not interact, then the clinician must focus therapy on both. However,

if there is a co-dependent relationship between phonological and morphosyntactic production then one could propose that intervening in one domain may indirectly promote improvement in the other. There are three basic ways in which to view the relationship between phonological and syntactic production: (a) syntactic production governs phonological production (Top-Down Model) (Garrett, 1984; Panagos, 1982), (b) phonological and syntactic production have bidirectional influences upon one another (Top-Down and Bottom-Up Model) (Panagos, 1982), or (c) phonological and syntactic production interact (Bucket Theory of Language Production [Crystal, 1987] and Parallel Interactive Activation Model [Stemberger, 1985]). These three perspectives are addressed in the following section. Each model is examined, and the implications of each with regard to intervention focus are proposed.

Models of Indirect Effects of Phonological Development on Morphosyntactic Production

The Issue of Competence

Models of language production assume underlying competence. Competence is referred to as a persons underlying ability to understand the principles behind the structure of a language (phonology, morphology, and syntax). In the present investigation, it is essential to distinguish between knowledge of the structure of a language, competence, and the way in which this structure is used, performance, in order to accurately examine the processes of production (Langacker, 1968).

Langacker (1968) presented the following explanation regarding the distinction between competence and performance:

> A language is a set of principles establishing correlations between meanings and sounds [competence]. These principles underlie and make possible communication by means of overt verbal behaviour [performance]. A language is a set of principles that a speaker masters; it is not anything a speaker does. (p. 35)

Thus, when examining the models of language production, what the speaker does, it is necessary to decide whether these models assume age-appropriate competence of a language or not. In other words, do these models assume intact competence? The underlying assumption of these models is that competence is intact. This assumption is based on childrens' comprehension abilities which like production depends on competence. Competence is demonstrated in how these models attribute errors in production. For instance, Garrett's model attributes errors to inappropriate retrieval and Stemberger's model attributes errors to inappropriate and/or failure in the activation of a linguistic unit. Thus, if errors are attributed to inappropriate retrieval or activation, the models must assume that an underlying representation (competence) of the linguistic units is there in order for this inappropriate retrieval and/or activation to take place. In other words, the production models presented in this study all assume that there are appropriate competence abilities in which the subjects can draw upon when attempting to produce the required syntactic, morphological, phonological, etc. forms.

The present investigation, which takes production models as its framework, assumes age-appropriate competence. This assumption is justified by the childrens' ability, which like production, depends on competence.

Top-Down Versus Bottom-Up:

There are two serial directions in which the relationship between syntactic and phonological production can be viewed: Top-Down and Bottom-Up (see Panagos, 1982 and Panagos & Prelock, 1982, for review). The first view, Top-Down, proposes that phonological structure is organized and controlled by syntactic structure, and that syntactic disorders may cause phonological disorders (Panagos, 1982; Panagos & Prelock, 1982). In other words, syntax governs "the selection of phonological features down to the level of articulatory behaviour" (Panagos, 1982 p.176). Thus, when syntactic processing becomes too demanding, the result is a breakdown in phonological processing which causes consonant misarticulations in word productions (Panagos, 1982; Panagos & Prelock, 1982).

Garrett's (1994)Model

Garrett (1984) proposed such a linear model of language production. In his model he proposes that sentence production is carried out in stages (see fig. 1.1), with syntactic processes either preceding or occurring at the same level as phonological processes. This type of linear model can lead to the following predictions about the relationship between syntax and phonology: syntax could have an effect on phonology or the two domains could be mutually inhibitory at the positional level, but phonology could never have a solely unidirectional effect on syntax. In other words, the derived prediction is that a therapy program that focuses on facilitating the development of syntactic production could promote the

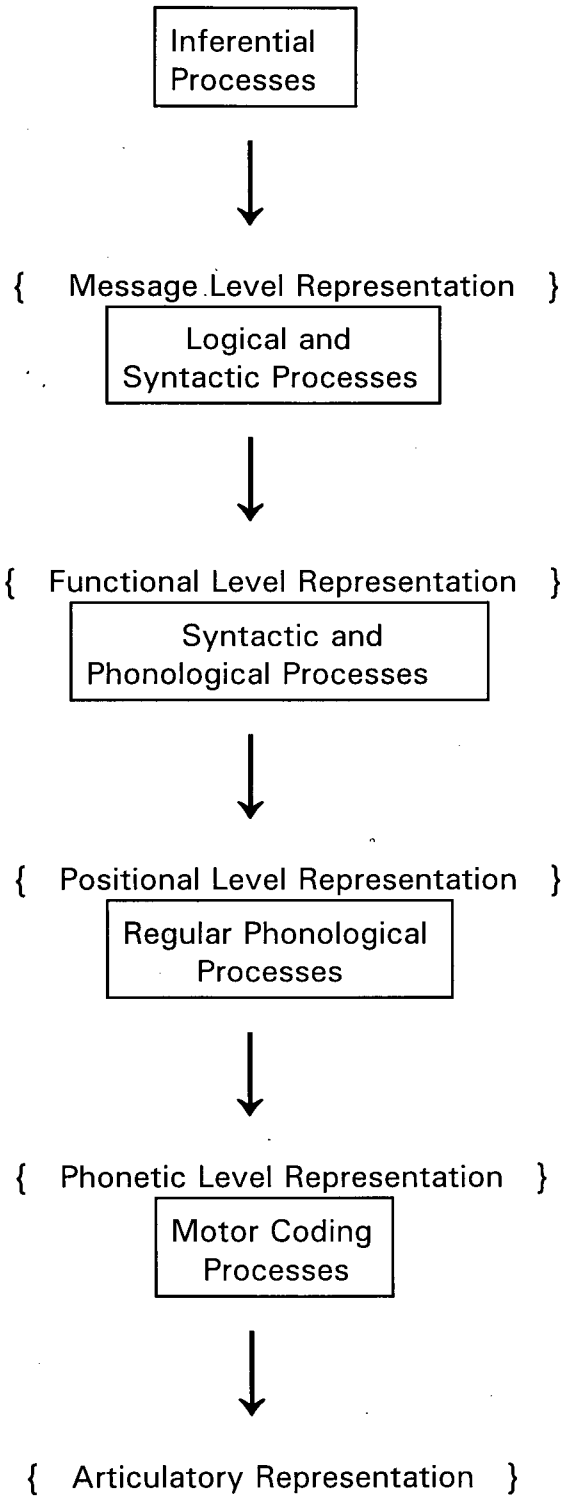

Figure 1.1. Garrett's (1994) model of the stages involved in language production.

development of phonological production in phonological and morphosyntactic impaired children. However, the reverse of this situation is not predicted; a phonological production therapy should not have a positive effect on the morphosyntactic production development of these children, as phonology has no governing relationship on syntax. Panagos and Prelock (1982) have found support for the Top-Down theory (syntax governs phonology) (Panagos, et al., 1979; Faircloth & Faircloth, 1970; Schmauch et al., 1978). In those cited studies it was found that as the demands of syntactic processing became greater (e.g. isolated words to sentences), their subjects consistently made more consonant misarticulations.

Panagos' (1982) Model

However, as Panagos and Prelock (1982) point out, this top-down theory has a notable weakness. It does not take into account the effect of phonological processing on syntactic processing: the 'bottom-up' perspective. Phonological processing could impair syntactic performance, and deficits in syntactic production could be caused by disruptions in phonological processing (Panagos & Prelock, 1982; Panagos, 1982). In other words, because of the relationship of the phonological system to the morphosyntactic components of language, (such as the ability to produce a word final consonant in order to produce the past tense form -*ed* or the ability to produce the fricative /s/ in order to produce the plural and/or possessive forms), malfunction of the phonological system could result in a morphosyntactic deficit (Whiticre, Luper, & Pollio, 1970). Panagos (1982)

proposes a 'feedback concept,' whereby in order to maintain proper syntactic processing and accuracy "some amount of feedback from the phonological system is needed" (p.177). He predicts that for children with both phonological and syntactic deficits, disruption when articulating particular words or phrases can cause and/or contribute to a syntactic production disorder. Panagos and Prelock (1982) tested and subsequently found support for this hypothesis and concluded that phonological structure influences children's syntactic processing. In their study, when subjects (aged 5;8 to 6;9) disordered in morphosyntactic production aged 5;8 to 6;9 repeated phonotactically complex words, they produced 27% more syntactic errors than when they repeated phonotactically simple words. In particular, as syllable complexity increased, the number of omission errors increased and simpler syntactic structures were used. Therefore, they suggested that increased phonological complexity disrupted syntactic processing and led to the simplification of syntactic patterns. As a result of their findings, they proposed that not only do sources of syntactic and phonological complexity "gang up" on phonological processing, they also work to impair syntactic processing. "Complexity added on either level -- syntactic or phonological -- disrupts performance on the other and cumulative complexity disrupts performance on both" (Panagos & Prelock, 1982, p.176).

Panagos (1982) presents a working model that displays the bidirectional (top-down and bottom-up) influences operating during children's sentence productions (see fig. 1.2). This model represents phonological and syntactic components that are encoded simultaneously, with each level being simplified in its own right and

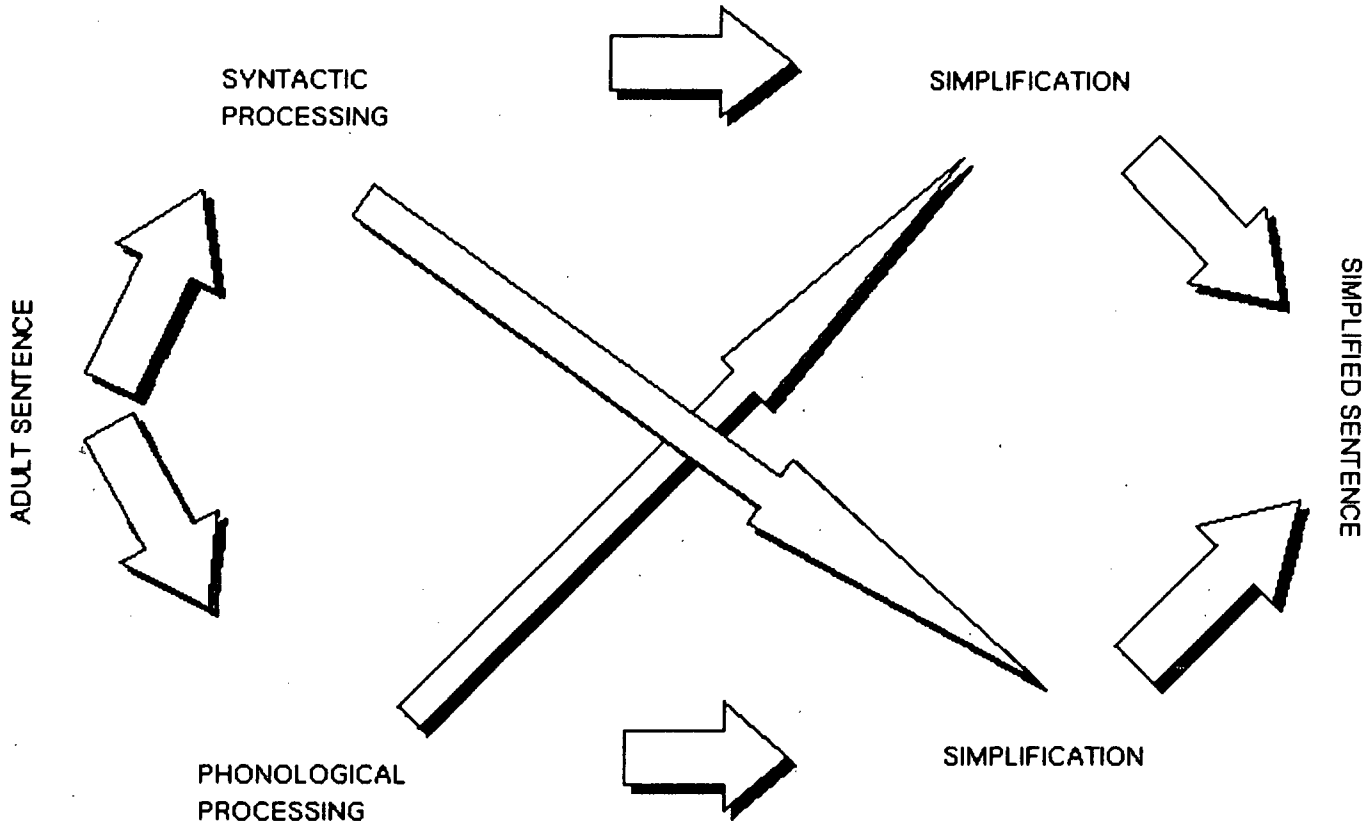

FIGURE 1.2 - Panagos (1982) - descriptive model of stages and processes of syntactic and phonological expression of language-disordered children.

each level influencing the simplification of the other. Panagos (1982) makes the following statement concerning the actual output of a child with both phonological and morphosyntactic impairments:

> Although simplification takes place across all levels of sentence expression, it is most apparent to the perceiver in the phonological component. Phonological simplifications do much to destroy speech and social intelligibility, placing the adult listener outside the child's speech code. (p.179)

Thus, if an adult is "outside of the child's speech code" because of the child's phonological simplifications, improving syntactic production through syntactic intervention techniques may seem inappropriate, because phonological simplifications could continue to reduce intelligibility. Thus, Panagos's model predicts that phonological intervention techniques may perhaps be more advantageous than morphosyntactic intervention techniques. Improving the encoding process of phonological processing could lead to a reduction of the simplification of syntactic structures and in turn improve syntactic processing overall. In this case the child will not alienate him/herself by producing unintelligible speech, but will be a more active participant in communication and, as a result, receive the appropriate feedback from the adult, needed to aid syntactic development.

Panagos's model proposes some interaction among the levels of syntactic and phonological performance. The levels are encoded simultaneously. Thus, the model represents a parallel rather than a serial processing process, and the simplification of one level influences the simplification of the other. The model, however, depicts a somewhat 'surface' level interpretation of the benefits of a

phonological intervention. Overall, it proposes that the improvements in morphosyntactic production development are a result of the child being better understood by others and thus, receiving more appropriate feedback from the adult, rather than a result of improvements between the interacting levels of phonology and syntax.

Crystal (1987) offers one model, whereby the interactive relationship of the levels of phonological and syntactic processing is examined. He proposes the following:

> Language processing capacity is likened to a bucket in which linguistic water has been poured. The bucket gets larger as the child develops; a language handicapped child has a series of holes at a certain level. As the child's language level rises extra water added will overflow via the holes. Thus, an extra drop of phonology may cause the overflow of a drop of syntax. (p.20)

This model could predict that phonological intervention would not dramatically effect and/or could possibly impair further the development of syntactic production in children severely impaired in both phonology and syntax. In other words, the "holes" in the disordered syntactic level could not be "filled in" by phonological intervention as this intervention does not directly target syntax. In addition, any extra phonological development as a result of phonological intervention may even cause more "overflow" in the area of syntax.

Stemberger (1985) proposes another model, whereby the interactive relationship of the levels of phonological and syntactic processing is examined and its effects on phonological and morphosyntactic production are analysed.

Parallel Interactive Activation Model

The Parallel Interactive Activation Model of language production (see fig. 1.3) represents a parallel processing system in which there is an interaction between the levels of language production (see Stemberger, 1985, for a complete description). In general, he hypothesizes that "the language system is an organized set of interconnected units" (Stemberger, 1985 p.146) known as Meaning, Syntax, the Lexicon, Phonology, Phonological Rules, Feature Access and the Articulatory Program. These units interact as follows:

> There are several levels, with links between units both within and between those levels. The links within levels tend to be inhibitory, with few units being selected for production on a given level. The links between levels tend to be activating, serving to influence the selection of units on adjacent levels of the system (Stemberger, 1985 p.146).

For instance, when a lexical unit becomes activated its link to the phonological level causes activation of the associated phonological units (e.g. segments, syllable patterns, etc.). The activated phonological units then in turn feed back up to the lexical level, resulting in an increase in the activation of the lexical unit. This unit then becomes "richer and richer" as it receives reinforcement from other levels. The result is the reinforced lexical unit inhibiting other units within the lexical level. Thus, "the rich get richer" as the chosen lexical unit gets reinforced and finally chosen for production.

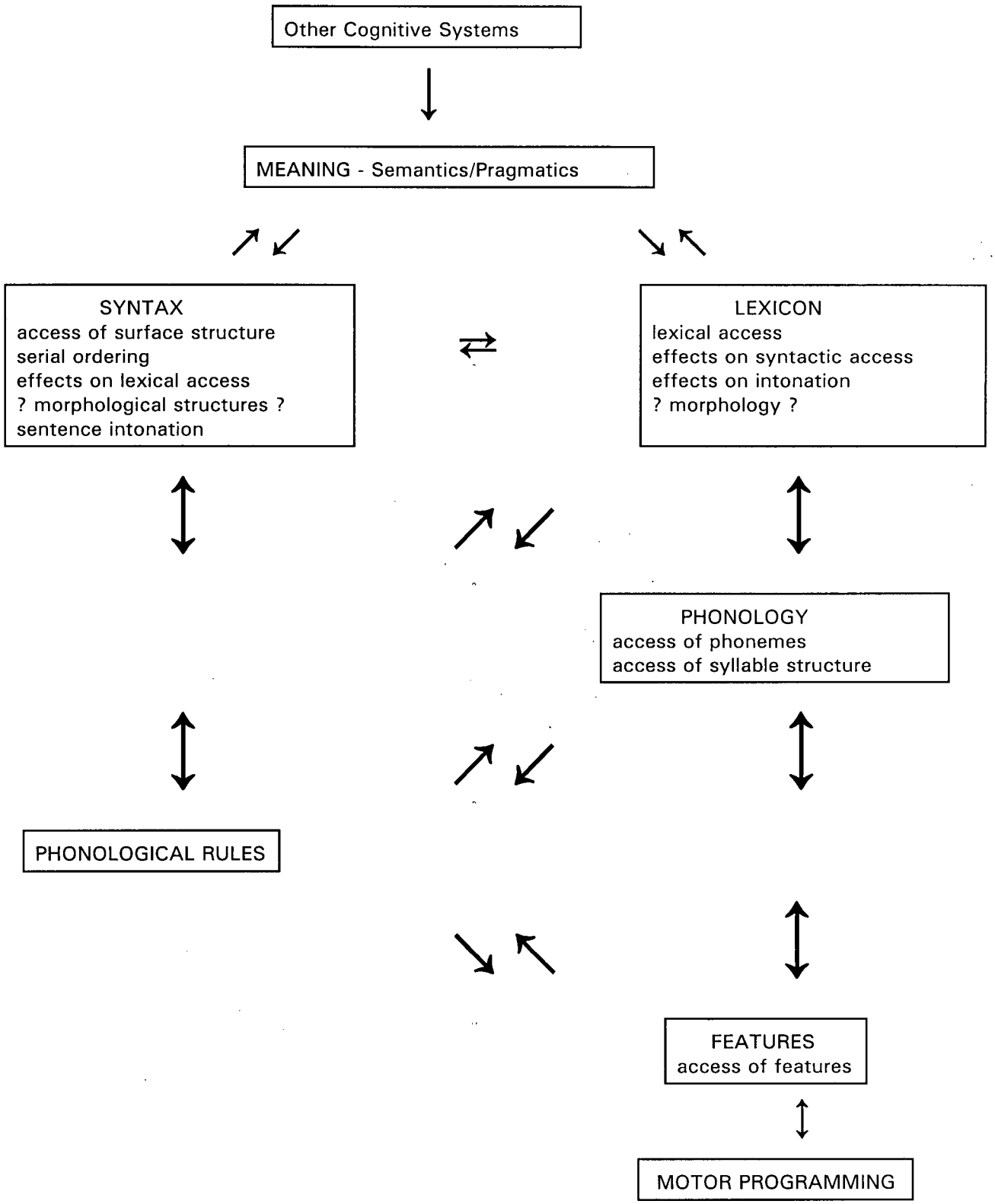

Figure 1.3. An interactive activation model of production. Stemberger (1985)

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This model can also shed some light on the following issues: (a) why a disordered phonological system may be accompanied by a disorder in morphosyntactic production, and (2) why focusing on phonological production in therapy may result in gains in morphosyntactic production. In general, one needs to master phonological skills in order to string words together (Stemberger, p.c.). A disorder at the phonological level can result in inappropriate phonological units being activated. Therefore, as these phonological units provide feedback to the associated levels (e.g. Lexical and Syntactic), the chosen units at the lexical and syntactic levels are not reinforced. Instead they may be inhibited by the inappropriate feedback from the phonological level. The result is that the appropriate lexical item and syntactic structure are not produced. In this

eventuality, instead of "the rich getting richer" and the appropriate lexical and syntactic units being reinforced and finally produced, the inappropriate feedback from the disordered phonological level may cause inhibition of these lexical and syntactic units and suppress production.

This model predicts that focusing on phonological production in therapy could result in gains in morphosyntactic production. If the appropriate phonological units are chosen at the phonological level, then the feedback given to the associated levels (e.g. lexical and syntactic) will no longer be inhibitory but, in fact, reinforcing. The result will be the correct selection and eventual production of the lexical and syntactic units required.

Recent disorder studies have tested the theories regarding the relationship between the domains of phonological and morphosyntactic production with respect to intervention focus. The effects of syntactic therapy and phonological therapy on their opposing domains have been examined with children impaired in both phonology and syntax.

Impact of Syntax on Phonology: Disorder Studies

Fey et al. (1994) examined the indirect effects of one type of syntactic intervention on the phonological performance of 4 - to 6 - year old children with severe morphosyntactic delay combined with a moderate to profound phonological delay. They found no secondary effects on phonological production as a result of their syntactic intervention and proposed that the development of morphosyntactic

and phonological production appear to be largely independent of one another. Thus, they concluded that clinical attention must focus directly on both domains for children who have impairments in both phonology and morphosyntax. But what of the effects of phonological intervention on morphosyntactic performance? Are the domains of phonological and morphosyntactic processing truly independent? This study attempts to answer these questions by examining the relationship between phonology and syntax from the other end of the spectrum addressed in Fey et. al. (1994).

Impact of Phonology on Syntax: Disorder Studies

Recent studies have examined the effects of phonological production on morphosyntactic output. Menyuk & Looney (1972) found that children who had problems repeating the phonological structure of a word also had problems in repeating the syntactic structure of a sentence. Panagos et. al. (1979) reported the correlation that children who make many phonological errors also make many syntactic errors when formulating their utterances. Paul & Shriberg (1982) concluded that up to 86% of children in their study with phonological production delays are also likely to have delays in their productive syntax. In their sample 86% of the children had syntactic deficits which were either *attributable* to or a *direct outcome* of their phonological deficits. In addition, Panagos and Prelock (1982) found that children disordered in syntax made 27% more morphosyntactic errors when reproducing sentences containing phonotactically complex words.

Aram and Kamhi's (1982) and Panagos's (1982) reviews proposed that children with phonological impairments also had deficiencies in syntax. The aforementioned studies then demonstrated that the relationship between phonology and syntax is a two-way street, with each domain having its effects on the other.

An Interactive Relationship

The concept of an interactive relationship among linguistic disorders has implications for the assessment and treatment of children who are phonologically and syntactically impaired. If one linguistic domain affects the other, further investigation is needed to examine the most effective type of intervention for children with both phonology and syntax disorders. For instance, should clinicians focus solely on phonological intervention or syntactic intervention or should they combine the two during treatment? Before this question can be appropriately addressed one must examine further the issues behind the relationship between phonological and syntactic production.

The Effect of Phonological Constraints on Syntactic Development

Past research has provided many examples to indicate that phonological intervention should indirectly influence syntactic development. First, the child's phonotactic constraints and phonological rules may function to prevent the phonetic manifestation of some underlying morphosyntactic forms

(Fey et al., 1994). For instance, final consonant deletion and cluster reduction can inhibit the production of plural, possessive, past tense, and third person singular in English. Researchers have also found that an increase in the phonological complexity of an utterance can lead to an increase in morphosyntactic errors (Panagos et. al., 1979; Panagos, 1982; Panagos & Prelock, 1982). These type of children seem to have difficulties encoding and producing both phonological and morphosyntactic operations concurrently. In particular, Leonard et al. (1988) compared Italian Specific Language Impairment (ISLI) children with English Specific Language Impairment (ESLI) children to determine how phonological factors influence their grammatical morpheme use. They concluded that phonological production does seem to be playing a significant role in contributing to SLI children's productive morphological impairments and found convincing evidence for The Phonology Hypothesis:

> ESLI children's extraordinary problems with certain features in language rest more in their difficulty in using grammatical features subject to phonological processes such as consonant cluster reduction and/or final consonant deletion than on the particular grammatical functions served by these features (p.40).

In other words, they hypothesize that children exhibit breakdowns in their morphological productions because of the difficulties they have in performing multiple cognitive operations simultaneously (Fey et al., 1994). For instance, Leonard et al.'s (1988) SLI subjects' difficulties with word-final consonant morphemes were attributed to word-final consonant deletion, and problems with syllabic morphemes were attributed to weak syllable deletion and/or phonotactic constraints (Fey et al., 1994). Thus, because of the excess demands of word-final

consonant and syllable production, morphosyntactic forms may be omitted (Fey et al., 1994). In addition, Fey and Stalker (1986) found that removing their subjects' "phonological obstacles" to the production of plural and possessive through phonological intervention resulted in "a very rapid and spontaneous development of the correct output forms of these inflections" (p.334).

Second, early multi-word constructions could be delayed by phonological constraints. For instance, Watterson (1978) suggested that children would begin producing longer utterances than they do if they had no constraints on articulatory planning and execution. Branigan (1979) argued that the onset of multi-word combinations is governed by the child's improved ability to plan articulations over larger linguistic units. He concluded that "the transition between the one and two word periods is one in which articulatory plans are undergoing reorganization to include syntactic and semantic information" (Branigan, 1979, p.420). In addition, de Villiers and de Villiers (1978) propose that the onset of word combinations may be delayed as a result of widely applied simplifying phonological rules that cross word boundaries. Donahue (1986) attempted to provide some support for these claims and described the interaction between one child's phonological system and his developing syntactic system. Her evidence concurred with the above. She found that consonant harmony constraints affected the transition from single to two-word utterances (Donahue, 1986). Matthei (1989) presented further evidence for the effect of phonological constraints on the development of multi-word utterances. He found a syllable sequencing constraint in his subject's syntax that seemed to govern the onset and form of her early multi word utterances.

Third, Fey et. al. (1994) suggested that additional lexical, propositional, and syntactic detail can reduce instead of improve the intelligibility of a child's utterance. Some phonologically impaired children seem to realize this result and thus, to overcome their phonological disorder, limit their utterance length and complexity (Fey et al., 1994).

The Focus Of Intervention

All of the above examples lead to the prediction that phonological intervention will result in gains in syntactic production for children impaired in both phonology and morhosyntax. Matheny and Panagos (1978) found that phonological intervention influenced syntactic development and syntactic intervention influenced phonological development. However, most recently Fey et al. (1994) examined the effects of morphosyntactic therapy on phonological development and found no indirect effects of the gains in productive syntax on their subjects' phonological output. They concluded that there is "no support for the hypothesis that effective facilitation of morphosyntax will also facilitate phonological development in children with phonological and morphosyntactic impairments" (Fey et. al., 1994, p.604). But what of the opposing hypothesis that effective facilitation of phonology will also facilitate morphosyntactic development in children with phonological and morphosyntactic impairments? Fey et al. (1994) suggest that spontaneous changes in morphosyntactic production may be observed when phonological constraints on production are relaxed as a result of phonological

intervention. However, they point out that successful phonological treatments appear to require additional syntactic intervention to aid children to acquire morphosyntactic forms and operations not directly limited by surface phonetic characteristics (Fey et al., 1994).

Tyler and Watterson (1991) also examined what type of intervention focus would be most efficacious for children with both phonological and syntactic disorders. They randomly assigned twelve subjects to two treatment groups (phonological intervention and syntactic intervention) and examined their development on the following phonological and morphosyntactic measures: (1) phonological: Percentage Consonants Correct (PCC), proportion of velar fronting , stopping, and cluster reduction, (2) morphosyntactic: Mean Length of Utterance (MLU), Developmental Sentence Score (DSS), and proportional use of copula. They found that the "phonological treatment group improved in both untreated and treated components [while] the language intervention group improved in only the treated component and regressed in the untreated component" (p.150). However, the differences found between pre- and post-measures were not significant. But, treatment was relatively short (two treatment sessions per week for nine weeks, with each child absent for approximately two sessions) and there was a marked difference in the severity level between the two groups. The syntactic intervention group had severe or moderately-severe disorders and the phonological intervention group had less severe (moderate to mild-moderate) disorders.

Tyler and Watterson (1991) suggest that level of severity of a child's phonological and morphosyntactic impairments can indirectly influence treatment

outcome. Specifically, the phonological treatment group had less severe disorders in addition to displaying differentially impaired phonology and syntactic development (Tyler & Watterson, 1991), whereas the syntactic intervention group displayed an overall severe disorder in both phonology and language. In addition, Hoffman et al. (1990) found a positive relationship between improvements in phonology and improvements in their subjects' productions of syntactically complete sentences after undergoing phonological intervention. These subjects were also found to have a difference in the severity level between their phonology and syntax, with their phonological productions falling in the moderately impaired range and their syntactic productions falling in the low-to-normal range (Hoffman et. al., 1990).

The Issue of Severity Level

Recently Tyler and Teipner-Sandoval (1994) examined the issue of severity level by analysing the treatment effects of intervention approaches on the domains of phonology and syntax for six preschool children with moderately severe impairments in these linguistic domains. The phonological and morphosyntactic measures examined were as follows: (1) phonological: PCC, and the phonological processes of velar fronting, initial/final cluster reduction, initial stopping of fricatives, and final consonant deletion, (2) morphosyntactic: MLU, Brown's stage and morphemes produced. They found that in both linguistic domains the two subjects in their direct phonology treatment group displayed moderate

improvement; the two subjects in their syntactic treatment group displayed small to negligible improvement; and the two subjects in their combined approach group showed the most improvement. Severity level again appeared to influence outcomes: the phonology group overall had less severe disorders than the syntactic group and the combined group overall had less severe phonological disorders than the others. Thus, they conclude that "interactions among linguistic domains are related to both treatment focus and the type and severity of children's language and phonological disorders" (p. 229) and propose that more investigation is needed to understand this relationship. However, as mentioned, each treatment group in this investigation contained only two subjects. Thus, the reliability and validity of the results are questionable.

The notion of a positive relationship between the severity of a phonological disorder and a syntactic deficit is not a new one, as demonstrated by past research (Aram & Nation, 1975; Aram & Kamhi, 1982; see Smit & Bernthal, 1983). As the level of severity of a phonological disorder increases, apparently so does the probability of a syntactic disorder (Shelton & Reynolds, 1979). Paul and Shriberg (1982) had subjects with more severe deficits and they found that up to 86% of them could attribute their morphosyntactic disorder to their phonological impairment. These authors suggested the "phonemic level of phonological processing [indicated by phoneme deletions and/or substitutions] interacts more with syntactic demands than does lower level phonetic processing" (p. 545). In addition, Smit and Bernthal (1983) found that "those with the articulatory impairment of syllable reducers who were judged to be more moderate to severely

impaired made more expressive syntax errors than either the mild to moderate substituters or the normals" (p.132). This last finding leads to another issue that addresses the link between a phonological impairment and a morphosyntactic production disorder: syllable structure. The argument is that if a child has such a severe phonological disorder that s/he is unable to build on a syllable then how can s/he be able to construct a phrase.

Prosodic Influences

Children impaired in both phonology and syntax may "lose" their ability to produce certain morphological features because they are unable to construct a syllable in which to place the segments. Nettelbladt (1983) examined the similarities between a normally developing child's syntactic and phonological patterns and those of highly unintelligible children with severe syntactic disorders. She found that at the one-word stage the normally developing child's language was restricted at the word level; for instance, there were restrictions on word length, harmony, positions and absence of prosodic contrasts. In addition, the normally developing child's language was also restricted at the syllable level; for example, CV and CVC syllable structures dominated. In this case the typically developing child was able to pass through this stage within 9 months; whereas, the disordered children took up to 3 years. Thus, Nettlebladt (1983) proposed that there may be a "connection between a child's phonological development and the initiation of syntactic and morphological development" (p. 152). Children impaired in both

phonology and syntax may be held back in their development of morphosyntactic production because of their inability to construct a syllable. Nettlebladt also went a step further with this idea and hypothesized that the ability to chunk syllables together into polysyllabic words may parallel the ability to chunk words together into phrases.

Gerken (1991) proposed a metrical hypothesis to account for children's word level and sentence level omissions. She found that preschool children tend to 'omit weakly stressed syllables, including pronouns and other morphemes, particularly from iambic (weak-strong) feet. In English the prominent element of the foot is on the left (Strong - Weak), for example, 'mon-key.' Thus, morphosyntactic production problems could arise from production constraints on the syllable. In other words, a syntactic explanation may not be appropriate to describe children's omissions of grammatically specified elements (Gerken, 1991). Instead, these syntactic omissions "may be linked to the processes that occur at the word level" (Gerken, 1991, p. 445). Therefore, it could be hypothesized that by working at the word level, as is done during nonlinear phonological intervention, and helping children to produce appropriate syllable structures, an improvement in morphosyntactic production could result.

Nonlinear Phonological Theory

Nonlinear phonological theory focuses on a hierarchical relationship among phonological units (Bernhardt & Stoel-Gammon, 1994). It assumes that there is an

organization of words, syllables, segments and features in a hierarchical fashion. For instance, "a word, as a part of a phrase/sentence, is composed of a number of progressively smaller units, each with its own representational tier/level" (Bernhardt & Stoel-Gammon, 1994, p.126) (Refer to fig. 1.4 for a representation.) A typical child is proposed to have this representational framework and the tier association principles in place when learning language. The theory of underspecificaton, however, suggests that not all syllable and feature information is encoded at each level when learning language. These units may be 'filled' in by the defaults. For instance, Bernhardt & Stoel-Gammon propose the following:

> At the level of the syllable the unmarked shape, (what the child brings to the language-learning process), remains CV until other syllable shapes become established through exposure to the input. At the level of the feature, default feature values (such as [-continuant] for consonants, yielding stops) are assumed until specified values are established (p. 132).

Therefore, a child who does not produce the specified forms and produces only the default forms (e.g., CV structure or stops) will be limited in his/her production of morphosyntactic forms such as, word final plural /s/.

Nonlinear phonological therapy directly exposes phonologically impaired children to a variety of syllable shapes. The therapy targets the development of prosodic structure by: (1) Establishing the basic syllable and word shapes of the target language (e.g. CVC, CVCVC, CCV, etc.) and (2) "Relaxing positional constraints for feature/segment realization so that syllable positions may become more specified for features (e.g. first with the glottal stop, then with nasal stops etc.)" (p134) (Bernhardt & Stoel-Gammon, 1994). Overall, nonlinear phonological intervention targets specifically and equally the ability of a child to construct a word

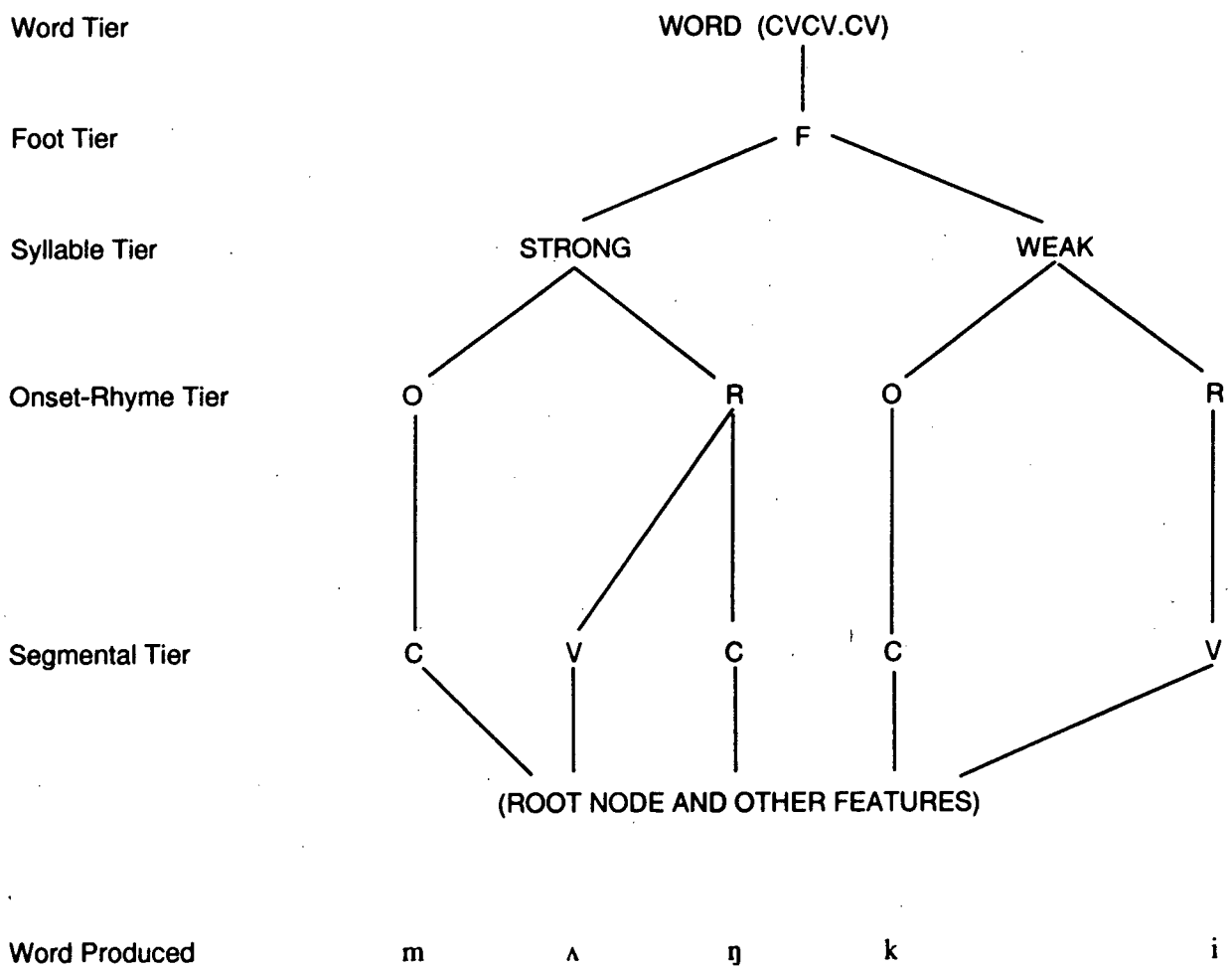

Figure 1.4. Hierarchical relationship amoung phonological units (Bernhardt & Stoel-Gammon, 1994)

at both the syllable and feature level. In turn a child can then develop the ability to build a phrase resulting in an increase in morphosyntactic development.

The Present Study: Purpose

The purpose of the present study is to examine the impact of direct nonlinear phonological intervention over 16 to 18 weeks on the development of morphosyntactical production in seven preschool children severely impaired in both phonological and morphosyntactic production. Further research is needed in this area of phonological and syntactic production for the following reasons. First, the phonological intervention implemented in such studies has been relatively short. As noted earlier, Tyler & Watterson (1991) conducted phonological therapy for only nine weeks held twice weekly with, each child being absent for approximately two sessions. Tyler & Teipner-Sandoval (1994) conducted phonological treatment for only twelve weeks, two to three times per week. The current investigation conducted phonological intervention three times a week for 16 to 18 weeks.

Second, to date research has not addressed the effects of phonological therapy on morphosyntactic production development with preschool children who are severely impaired in both domains of phonology and syntax, as Tyler and Teipner-Sandoval (1994) observed is necessary. Third, Tyler and Teipner-Sandoval found only moderate (insignificant) gains in syntactic production as a result of direct phonological therapy. However, there were only two subjects per treatment group, and, thus, the reliability and validity of this small sample size are

questionable. Finally, this study is the first to address the possible outcomes that nonlinear phonological intervention, specifically, could have on the development of of syntactic production. It is important to examine not only the different effects of phonological intervention as they relate to treatment time and the subjects' severity level, but also to the type of therapy provided. Thus, this study further examines the interactions among the linguistic domains of phonology and syntax and analyses their relationship to both treatment and severity type with seven severely impaired speech and language preschoolers. A theoretical interpretation of the findings is also presented.

Overall, this research examines the following question: Does nonlinear phonological intervention designed to facilitate the development of phonology have an indirect influence on children's morphosyntactic output? Specifically this study asks:

(1) Does phonological therapy lead to gains in morphosyntactic development for children severely impaired in both phonological and syntactic production?

(2) Are gains in phonology (as measured by Percentage of Consonants Correct [PCC] and Percentage of Word-shapes Matched [PWM]) correlated with gains in morphosyntax (as measured by MLU, Brown's stage, Index of Productive Syntax score [Scarbourough, 1990], number of morphological features produced, and Mean Length of Longest Utterance [MLUL] for children with severe phonological and morphosyntactic production disorders?

The answers to these questions will expand our understanding of the relationship between the linguistic domains of phonology, morphology, and syntax.

CHAPTER TWO

METHOD

Overview

The current investigation attempts to examine whether therapy facilitating phonological production development has any indirect influence on the development of morphosyntactic production for children severely impaired in phonological and syntactic production. The experimental questions and their associated null hypotheses are as follows:

(1) Does phonological therapy lead to gains in the development of morphosyntactic production for children severely impaired in phonological and syntactic production?

Null hypothesis: There will be no direct effects on the domain of morphosyntactic production as a result of phonological intervention for this population of children.

(2) Are gains in phonology (as measured by PCC and PWM) correlated with the gains in morphosyntax (as measured by MLU, Brown's stage, IPSyn, Number of morphological features produced, and MLUL) for children with severe phonological and syntactic production disorders?

Null hypothesis: There will be no correlation between any gains measured in phonology and any gains measured in morphosyntax for this population of children.

Subjects

Subjects were nine preschool children, aged 3;0 to 4;3 (mean age 3;7). All subjects were from the province of British Columbia and judged to be from an equivalent low-middle socioeconomic income status. All subjects were participating in an ongoing study examining the efficiency of nonlinear phonological intervention, conducted by Bernhardt (1994). Subjects were chosen according to the type and severity level of their disorder(s). Seven of the subjects were experimental group subjects (five male, two female). These subjects were found to have had both severe phonological and morphosyntactic production disorders at the beginning of the study. Two other reference control subjects had only a severe phonological disorder (both male). They were chosen from the same ongoing investigation by Bernhardt (1994). The reference control subjects were used as pseudo-controls for the study as they did not display any morphosyntactic production deficit. Due to the lack of appropriate controls to match experimental subjects on a one-to-one basis, only two subjects were chosen to act as controls. These two subjects were chosen as they were the only children in the Bernhardt (1994) investigation to fit the following criteria for control reference subjects at the onset of the current investigation: (1) both displayed only a severe phonological disorder and, (2) both were of different age levels (S8 was 3;6 and S9 was 4;3) in order to account for the varying ages of the experimental subject group. Results from these two subjects are to be used as reference only, as statistical analyses will not provide valid results.

Phonological Production Measures

Phonological production measures to assess each child's level of phonological deficit were taken at two points in the study: one week prior to the onset of therapy (Time 1) and one week post-therapy (Time 2). Phonological production measures were taken from an elicited list of words identical for each subject. The number of words produced by each child ranged from 102 to 431 for the pre-therapy (Time 1) list and 161 to 375 for the post-therapy (Time 2) list. An average of 42.6% (range: 7.8% to 76.5%) of words elicited at Time 1 and 34% (range: 11.6% to 67.7%) at Time 2 were spontaneous productions. Word lists were narrowly transcribed according to the International Phonetic Alphabet (IPA) at the University of British Columbia by three graduate students in the School of Audiology and Speech Sciences.[1] Interjudge reliability was found to be 81% point to point before discussion and 100% after discussion for single word productions. For connected speech productions reliability was 95% before discussion over two transcribers for connected speech productions. Variations in transcriptions were found for glottal stops, vowel length, and voiced versus aspirated quality of word-initial stops.

The subjects' overall phonological assessment results at Time 1 are summarized in Table 1. All children had severely restricted phonetic inventories, with an average of 7.2 (range: 3 to 10) phonemes completely absent from the

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[1] There was only one transcriber for each individual child's sample.

Table 1. Phonological assessment results: Time 1

Subject	PCC (%)	PWM (%)
Experimentals:		
S1	34%	9%
S2	21%	15%
S3	29%	35%
S4	27%	14%
S5	21%	13%
S6	29%	14%
S7	31%	21%
Reference Controls		
S8	19%	.05%
S9	38%	11%

inventory. The level of phonological deficit was measured by both the Percentage of Consonants Correct (PCC) (Shriberg & Kwiatkowski, 1982) and Percentage of Wordshapes Matched (PWM). For each subject, PCC's were calculated for individual word positions (e.g., Word Initial (WI), Word Final (WF), Initial Consonant within word (IC), and Final Consonant within word (FC). However, the overall PCC score for each child presented in this investigation was calculated across all word positions.[2] Percentage of Wordshapes Matched (PWM) is a measure which compares the number of times a child's production of a wordshape (e.g. CVCV) matches that of the adult target. The PWM was calculated with a new computer program known as Speech.app (Bernhardt & Cam, 1994). This program provides various summary tables, including wordshapes matched and phonemes matched by word position. The PCCs ranged from 21% to 38%, with an average of 27.6% and PWM ranged from .05% to 35%, with an average of 14.7%. Overall, all subjects' severity levels in phonological production were judged to be severe.

Standardized Assessment Measures: Comprehension

Standard assessment measures for each subject's comprehension of language included the following: (a) The Peabody Picture Vocabulary Test - Revised (PPVT-R) (Dunn & Dunn, 1981), (b) the Test of Auditory Comprehension of Language - Revised (TACL-R) (Carrow-Woolfork, 1985), (c) Reynell

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[2] Clusters were not included in PCC calculations.

Developmental Language Scales - Receptive Language Score (Reynell, 1977) and (d) the Preschool Language Scale (PLS)/or PLS-3 (Zimmerman et. al, 1979). Refer to Table 2 for reported results. Standardized tests used for each subject were not consistent. Subjects originated from all over British Columbia and each had different Speech-Language Pathologists. Thus, identical standardized tests for comprehension of language were not used, although several were the same. However, all nine subjects performed within the average range in their comprehension of language.

Previous Intervention

Prior to the onset of this study only two subjects had received any previous speech and/or language therapy. Subject 7 received three sessions of articulation therapy and subject 3 received speech and language stimulation therapy once a week for 5 months. Both of these subjects are in the experimental group in the present study. In addition, both S7 in the experimental group and S9 in the reference control group received minor morphophonemic training during the study. Subject 7 received minimal focus on the "-ing" and plural /z/ features in the context of a CVCVC structure during the second block of treatment (at approximately 8 to 14 weeks). Subject 3 received minimal focus on the third person plural and plural features in the context of a CVCC structure during the third block of treatment (at approximately 14 to 16 weeks).

Table 2. Standardized Assessment Measures - Comprehension

SUBJECT	Gender	C.A.	TEST	STANDARD SCORE	PERCENTILE	AGE* EQUIVALENT
Experimentals						
S1	M	3-6	PPVT-R			4-3
			TACL-R			2-10 to 3-0
S2	M	3-5	PPVT-R	95	37	3-1
			PLS - AC subtest			4-3
			PLS - VA subtest			2-7
			PLS - Total			3-5
S3	M	3-3	PPVT			3-11
			PLS -AC subtest			3-9
			PLS - VA subtest			2-6
S4	F	4-2	PLS-3 - AC subtest			4-6
			PLS-3 - VA subtest			3-6
			TACL-R		35	3-7 to 3-10
S5	F	3-4	PPVT	88		
			RDLS* -receptive scale			(av. score: - 0.8)
S6	M	3-0	PPVT	97	42	2-11
			RDLS - receptive scale			(av. score: - 0.8)
S7	M	3-5	PPVT			(average range)
			TACL-R			(average range)
Reference Controls						
S8	M	3-11	PPVT	102	55	3-7
			TACL-R		66	4-0 to 4-2
S9	M	3-10	PPVT	101	52	3-11

* Standard scores and Percentiles were not available for all subjects

**RDLS = Reynell Developmental Language Scales

All subjects displayed hearing within normal limits and oral musculature function adequate for typical speech sound development at the time of the study.

DESIGN

Phonological Intervention Project

Subjects were chosen participants in an ongoing nonlinear phonological intervention study with Bernhardt (1994) as principle investigator. Intervention occurred three times a week for 16 to 18 weeks, with caregiver participation. The individual goals for each subject are outlined in Appendix A. Due to illness and other unexpected delays, treatment duration in the study was 4 to 8 months, with an average of 6 months between Time 1 and 2 across all nine subjects. The individual 45-minute sessions were conducted by each subject's local Health Unit Speech-Language Pathologist or Bernhardt, for subjects 3 and 7. Tape and/or audio recordings of an elicited word list and language sample (pre- and post- therapy only) from each subject were sent in to U.B.C. before the onset of treatment and then at every 7 to 9 weeks until the conclusion of therapy. Bernhardt set the phonological goals for each child (see Appendix A for a list of individual goals for each child throughout the therapy).

Nonlinear Phonological Intervention

Nonlinear phonological intervention consists of the following (please refer to Bernhardt [1990, 1994b] for a more detailed description): Phonological goals are derived through analysing each child's Feature Geometry and word structure. Targets for intervention are chosen in the following ways: (a) combining features already present in the child's inventory to establish a new phone, (b) introducing a completely new feature to his/her inventory in order to establish a new phonological production, (c) mapping/copying a phone to a new word position and, (d) establishing new word shapes. Periods of time allotted to each goal were identical in the study and followed a cyclical approach, with three blocks (cycles) of treatment. Please refer to Appendix B for a complete description of the components of therapy.

Word structure therapy then capitalizes on the following theories: mora theory and onset-rhyme theory (refer to Appendix B and Bernhardt et al., 1994, for a complete description).

Research Design

The current investigation asks whether nonlinear phonological intervention has any indirect influence on the development of morphosyntactic production for children severely impaired in phonological and syntactic production. The null hypothesis is that there will be no direct effects on the domain of morphosyntactic

production as a result of phonological intervention for this population of children. In addition, this investigation examines whether any gains observed in the domain of phonological production are correlated with any gains observed in syntactic production. The null hypothesis, in this case, is that there will be no correlations between gains found in phonological production measures and gains found in morphosyntactic production measures.

Procedures

Morphosyntactic Production Measures

Measures to assess each child's level of productive morphosyntactic deficit before (Time 1) and after (Time 2) treatment were derived from spontaneous language samples. These samples were taken approximately one week previous to and one week following intervention. In addition, language samples were taken during word elicitation sessions, therefore, stretches of single word elicitations were omitted from the samples as they were felt to biasing. Each language sample was transcribed in the Codes for Human Analysis Transcripts (CHAT) format of the Child Language Data Exchange System (CHILDES) (MacWhinney, 1994). CHAT provides a way of recording computerized transcripts of conversational interactions, and the accompanying Computerized Language ANalysis (CLAN) programs allow one to conduct automatic analyses of this data. Utterances that were imitations of the adult model, self-repetitions, or contained unintelligible productions were omitted from the analysis. On the average, 31% of utterances at Time 1 were

considered to be unintelligible (range = 11% to 46%) and 29% of utterances at Time 2 were considered to be unintelligible (range = 12% to 47%).[3] An equal number of intelligible utterances from each subject's Time 1 and Time 2 samples were analysed, with an average of 69 utterances in each sample (range = 44 to 94) (refer to table 1 for breakdown by subject). Interjudge reliability rating for the spontaneous language samples was found to be 95% over two transcribers for the utterances in two randomly selected transcripts. Specifically, a 94% (137/146) interjudge reliability rating was found for the least intelligible subject in the experimental group and a 96% (180/187) interjudge reliability rating was found for the "most talkative" of the experimental control subjects.

The level of morphosyntactic production deficit was measured by the following:

(a) Mean Length of Utterance (MLU) calculated by the CLAN program on the CHAT system for transcript coding (MacWhinney, 1994).

(b) Index of Productive Syntax (IPSyn) (Scarborough, 1990). The IPSyn was chosen as a measure in the present study after an exhaustive search to find ways to analyse phrase structure. Standardized tests were insufficient to measure

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[3] An utterance was considered to be unintelligible if one or more of the productions within that utterance were not understood. Only completely intelligible utterances were included in the analyses of each subject's morphology and syntax. The fact that there appears to be no improvement in utterance intelligibility rating between Time 1 and Time 2 is felt to reflect each subject's increased MLU at Time 2 (see Table 6). An increase in the number of productions within an utterance could result in an increase in the production of an unintelligible word within each utterance. Thus, subjects were penalized equally at Time 1 and 2; that is, if a minimum of one unintelligible production was made within an utterance, then the entire utterance was omitted.

spontaneous samples, and other measures such as the SALT-II (Miller & Chapman, 1991) and CLAN (McWhinney, 1994) program, mentioned above, were inadequate for phrase structure analysis. The IPSyn is a method for describing the syntactic complexity of preschoolers' natural language samples (Scarborough, 1990). Its purpose is to provide a summary scale of syntactic complexity to study individual differences in language development (Scarborough, 1990). In general, types (not tokens) of syntactic productions *used* by an individual subject are examined. The result is a "measure of the *emergence* of syntactic and morphological capabilities, but not of their *mastery*" (Scarborough, 1990 p.2). Interjudge reliability was found to be 89% on average over two judges for two randomly selected language samples. Specifically, an interjudge reliability rating of 84% (21/25) was found for an experimental subject's IPSyn score and a 94% (65/69) interjudge reliability rating was found for a control reference subject's IPSyn score. Differences in IPSyn scores were randomly distributed across the categories.

There are limitations reported on the use of IPSyn (see Scarborough, 1990) and even in the present study, the exact guidelines for its use were not followed as the number of utterances per sample per child did not reach the required 100 after exclusion of utterances as indicated above. Number of utterances per sample ranged from 54 to 94. Because of the low number of utterances, the IPSyn score may not be representative of the child's language production abilities and may in fact underestimate them. However, the reported IPSyn results are interpreted with caution and are used only in conjunction with and to provide further support for the other more reliable and valid language measures reported.

(c) Brown's (1973) stage of grammatical morpheme usage. Morphemes produced for each child were coded and analysed by the CLAN program. CLAN provided a summary list and frequency count of every morphological feature and an MLU rating for each subject. Morphology usage was noted and an MLU score provided a categorization of Brown's stages.

(d) Number of grammatical morphemes used. The number of types of grammatical morphemes used by each subject (summarized by the CLAN program) was counted at Time 1 and Time 2[4]. Interjudge reliability for the coding of morphological features on the CHAT system for transcript coding was found to be 97% over two transcribers. Specifically, a 97% (93/96) interjudge reliability rating was found for one experimental subject and a 97% (325/334) was found for one of the control reference subjects. A summary of each child's morphological inventory at Time 1 is presented in Table 3.

(e) Mean Length of longest utterance (MLUL) was calculated by finding the mean in morphemes of the five longest utterances produced. The decision to examine the MLUL stems from Rondal et al.'s (1987) findings regarding the limitations of correlating MLU with syntactic complexity. This research found that the validity of mean utterance length for predicting syntactic complexity and diversity appears to be less reliable after an MLU of 3.0 (range from 2.5 to 3.5). This MLU of 3.0 correlates with Brown's stage III and falls within the age range of approximately 31

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[4] A morphological feature present at Time 1 and not present at Time 2 was still considered to be within that child's inventory at Time 2. Thus, at Time 2 the number of morphological features observed was the result of the number present at Time 1 added to the number of *new* features produced at Time 2.

Table 3. Grammatical morphemes produced: Time 1

SUBJECTS																	
Experimentals														Reference Contols			
S1	adj	S2	adj	S3	adj	S4	adj	S5	adj	S6	adj	S7	adj	S8	adj	S9	adj
	adv		adv		adv		adv		adv		adv		adv		adv		adv
	det:poss		co		det		conj:coord		co		conj:coord		co		co		conj:coord
	det		neg		neg		det:poss		det:poss		co		n:prop		det:poss		conj:prag
	neg		n		num		neg		det		det:poss		num		det		det:poss
	num		n-poss		n		n		inf		det		n		inf		det
	n		n-pl		pro:indef		n-pl		n:prop		neg		pro:dem		neg		inf
	prep		prep		pt		prep		num		n		pro:indef		num		n:prop
	pro:indef		pro:dem		qn		pro:dem		n		prep		pro		n		neg
	pro		pro		v:imp		pro:indef		prep		pro:dem		pro:poss		prep		n
	pt		v:imp		v		pro		pro:indef		pro:imdef		pt		pro:dem		n-pl
	qn		v		wh:adv		pt		pro		pro		qn		pro:indef		prep
	v:aux		v-prog				v:aux		pt		qn		v		pro		pro:dem
	v						v + 3S		qn		v:imp				pt		pro:indef
	v-past						v		v:imp		v				qn		pro
							v-prog		v		v-prog				v:aux		pt
							v-past				wh:pro				v:imp		qn
							wh:adv								vlbe & pres		v:aux
							wh:pro								v		v:aux-past
															v-prog		v:imp
															v-past		vlbe &3S
															wh:pro		vlbe & 1S
																	v-past
																	v-prog
																	v
																	wh:adv
																	wh:pro

to 36 months according to Brown (1973). Therefore, another means of examining productive language development beyond an MLU of 3.0 was necessary. Wells (1985) observed that MLUL was a reliable measure of productive syntactic complexity up to the age of 42 months. This age level corresponds to approximately Brown's stage V. Thus it was felt that, as the average age level of the subjects in the present study at Time 1 is 43 months, MLUL could offer a more reliable index of syntactic complexity than MLU alone.

The productive morphosyntactic assessment results are summarized in Table 4. The experimental subjects were found to have:

(a) MLU's ranging from 1.123 to 2.432, with a Mean of 1.79, S.D. = 0.44.

(b) syntax production scores (IPSyn) ranging from 17 to 49, with a Mean of 28.9, S.D. = 7.70.

(c) an assigned Brown's Stage ranging from early I to II with an average of stage of late I, Median = late I.

(d) a range of 12 to 19 grammatical morphemes produced, with a Mean of 15, S.D. = 2.33 . (refer to Table 3 for a list of morphemes produced for each subject at Time 1).

(e) a MLUL ranging from 2 to 6, with a Mean = 3.8, S.D. = 1.18.

Overall, the experimental subjects' severity level in morphosyntactic production is judged to be severe.

Table 4. Morphosyntactic assessment results: Time 1

SUBJECT	MLU	BROWN'S STAGE	IPSYN	# of MF *	MLUL**	# of Utterances Per Sample
Experimentals						
S1	2.27	II	35	15	5	72
S2	1.12	Early I	49	13	2	80
S3	1.37	Early I	17	12	2.4	58
S4	2.43	II	32	19	5.2	60
S5	1.65	Late I	21	16	3.4	54
S6	1.99	Late I	27	17	4.4	94
S7	1.71	Late I	21	13	3	70
Reference Controls						
S8	3.78	Early V	45	22	5.2	75
S9	4.82	V+	71	27	11.2	69

* # of MF = Number of Morphological Features

** MLLU = Mean Length of Longest Utterance

On the other hand, the reference control subjects were found to have:

(a) MLU's of 3.78 and 4.82.

(b) productive syntax scores (IPSyn) of 45 and 71.

(c) assigned Brown's Stages of V and V+.

(d) number of grammatical morphemes produced 22 and 27. (See Table 4 for types of grammatical morphemes produced at Time 1).

(e) MLUL's of 5.2 and 11.2.

Thus, the reference control subjects were judged to be age-appropriate in morphosyntactic production abilities.

CHAPTER THREE

RESULTS

Phonological Measures

In order to answer the question, "Does phonological therapy lead to gains in morphosyntactic development for children severely impaired in phonological and syntactic production?," it must first be established that the therapy did indeed result in significant gains in phonological development. The variables used to measure the subject's phonological production are PCC and Percentage of WordShapes Matched (PWM). All nine subjects displayed severe intelligibility difficulties. Thus, the reference were controls included in the experimental group for those measures (refer to Table 5 for a summary of phonological results).

Both the Sign Test and the Wilcoxon Signed Rank Test were used to compare intelligibility measures (PCC and PWM) recorded at Time 1 (pre-therapy) and Time 2 (post-therapy) (see figures 3.1 and 3.2 for a graphical display of results). The null hypothesis (H) states that there will be no significant improvement in both the PCC and the PWM measures from Time 1 to Time 2. The Sign Test results were, H: $M_D = 0$ vs. K: $M_D > 0$, $S_+ = 9$ $S_- = 0$. The null Hypothesis (H) is rejected for both the PCC and PWM measures ($P(S_+ \geq 9) = 0.002$). The Wilcoxon Signed Rank Test was also used to analyse the effect of treatment on the intelligibility measures, by taking into account the magnitude of

Table 5. Phonological assessment results: Pre- and post- intervention (Time 1 vs. Time 2)

	Time 1: Pre-intervention		Time 2: Post-intervention	
Subject	PCC %	%Wordshape Match	PCC %	%Wordshape Match
Experimentals:				
S1	34%	9%	62%	28%
S2	21%	15%	55%	37%
S3	29%	35%	65%	65%
S4	27%	14%	34%	30%
S5	21%	13%	27%	15%
S6	29%	14%	31%	14%
S7	31%	21%	68%	63%
Reference Controls:				
S8	19%	.05%	31%	25%
S9	38%	11%	78%	72%

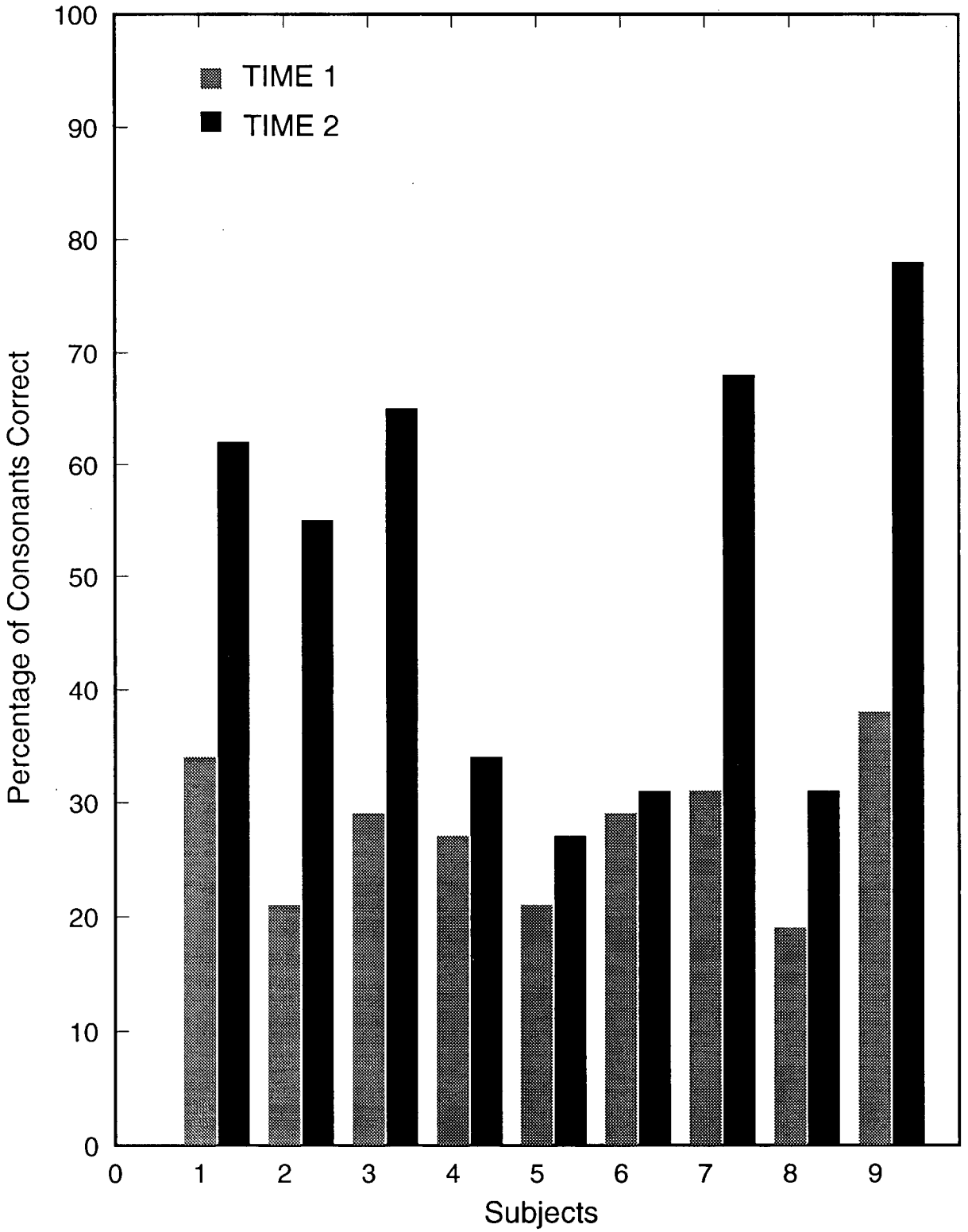

Figure 3.1. Percentage of consonants correct: Time 1 (pre-intervention) versus Time 2 (post-intervention).

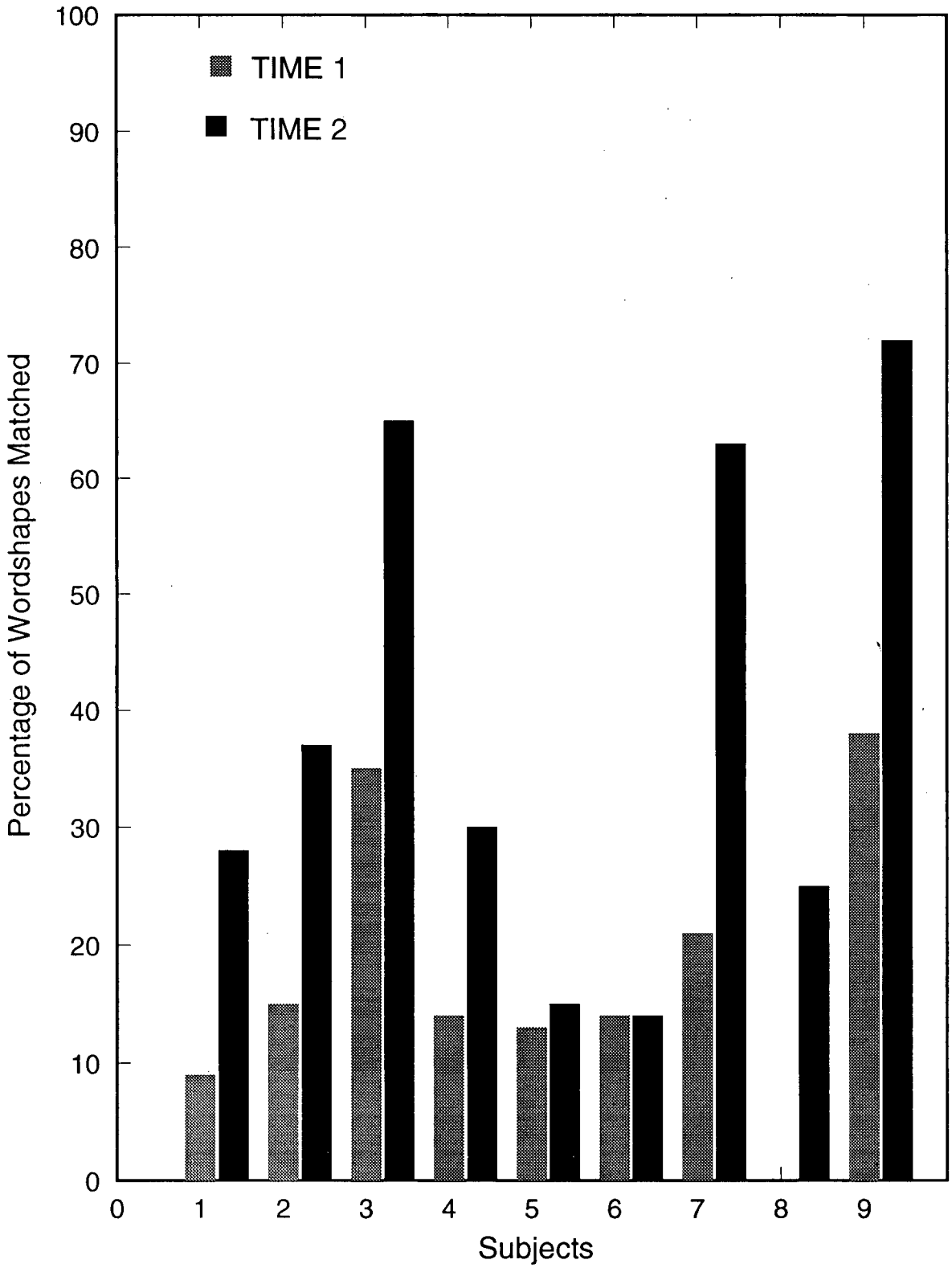

Figure 3.2. Percentage of word shapes matched: Time 1 (pre-intervention) versus Time 2 (post-intervention).

difference between Time 1 and Time 2. In this case, H is also rejected for both of intelligibility measures ($T_+ = 45$, $T_- = 0$, $P(T_+ \geq n(n + 1)/4 = 0.002)$. Therefore, there is a significant difference in phonological measures between Time 1 and Time 2.

The Kruskal-Wallis Test was attempted to examine whether the improvement observed in intelligibility measures for the reference controls was significantly greater than that of the experimental subjects. Because the reference control subjects did not fall at the extremes of the rankings this one-sided test was unable to derive any significant results.

Morphosyntactic Measures

In order to determine whether these successful efforts to facilitate gains in phonology led to gains in syntactic production development, morphosyntactic measures from Time 1 were compared to those of Time 2 (refer to Table 6). The variables used to measure morphosyntactic production development were: MLU, Brown's Stage, Number of morphological features, IPSyn and Mean Length of Longest Utterance. The graphical display of these data is presented in figures 3.3 to 3.7b. Since only seven subjects displayed a severe morphosyntactic production deficit (the experimental group) at Time 1 and the remaining two were found to have no significant morphosyntactic production delay (the reference controls), the

Table 6. Morphosyntactic assessment results: Pre- and Post- intervention (Time 1 vs. Time 2)

Time 1 Subject	MLU	Brown's Stage	IPSyn	# of Morph. Features	MLUL
Experimentals:					
S1	2.27	II	35	15	5.o
S2	1.12	Early I	19	13	2
S3	1.37	Early I	17	12	2.4
S4	2.43	II	32	19	5.2
S5	1.65	Late I	21	16	3.4
S6	1.99	Late I	27	17	4.4
S7	1.71	Late I	21	13	3
Reference Controls:					
S8	3.78	Early V	45	22	5.2
S9	4.82	V+	71	27	11.2
Time 2 Subject	**MLU**	**Brown's Stage**	**IPSyn**	**# of Morph. Features**	**MLUL**
Experimentals:					
S1	4.06	Early V	55	21	8.2
S2	2.90	III	49	26	6
S3	2.74	III	44	23	6
S4	4.50	Late V	45	24	10.6
S5	2.68	III	36	22	5.8
S6	3.42	Early IV	43	24	7.4
S7	2.06	II	32	22	5
Reference Controls:					
S8	4.08	V	58	26	6.4
S9	4.85	V+	69	30	9.8

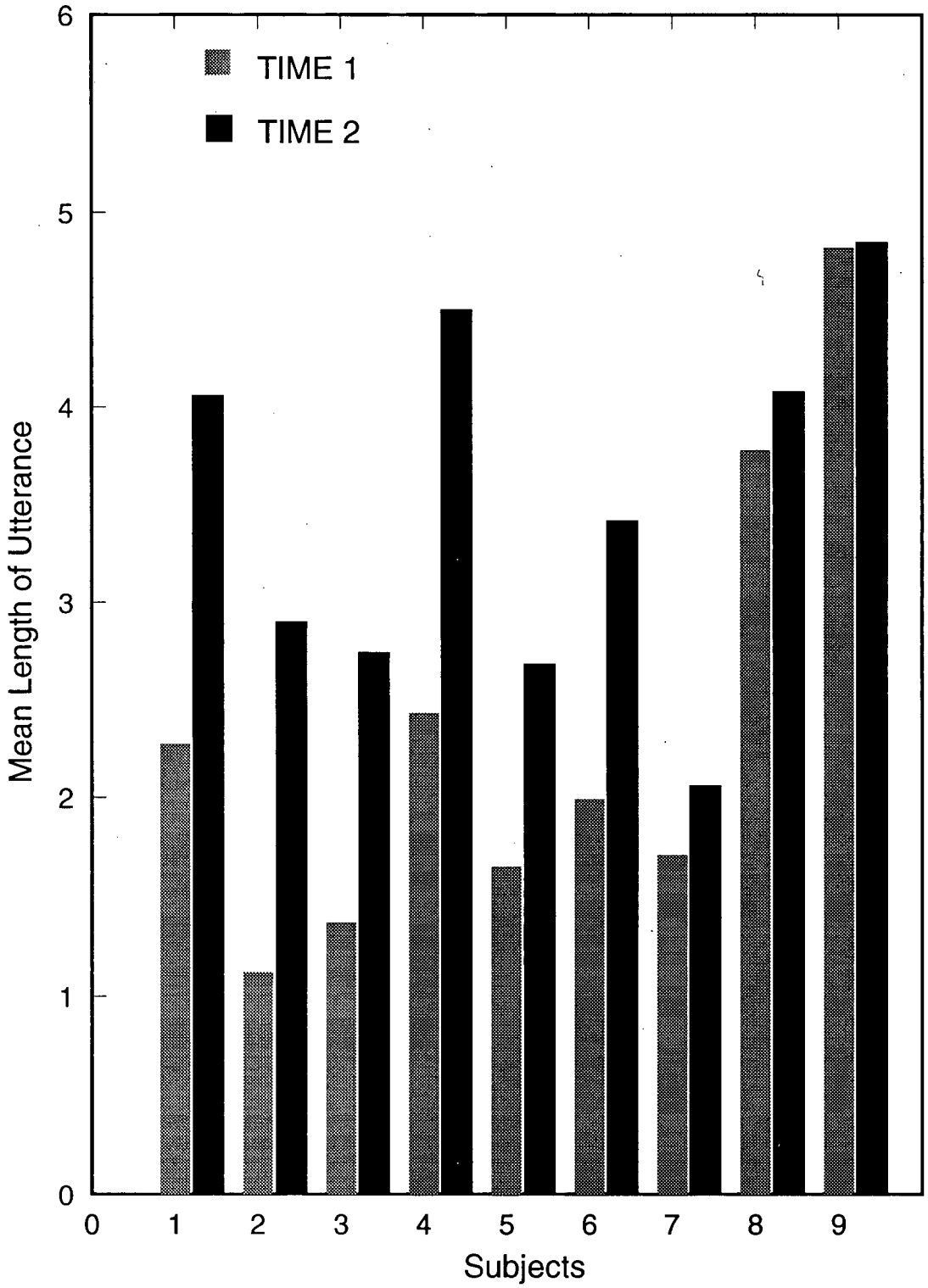

Figure 3.3. Mean Length of Utterance: Time 1 (pre-intervention) versus Time 2 (post-intervention).

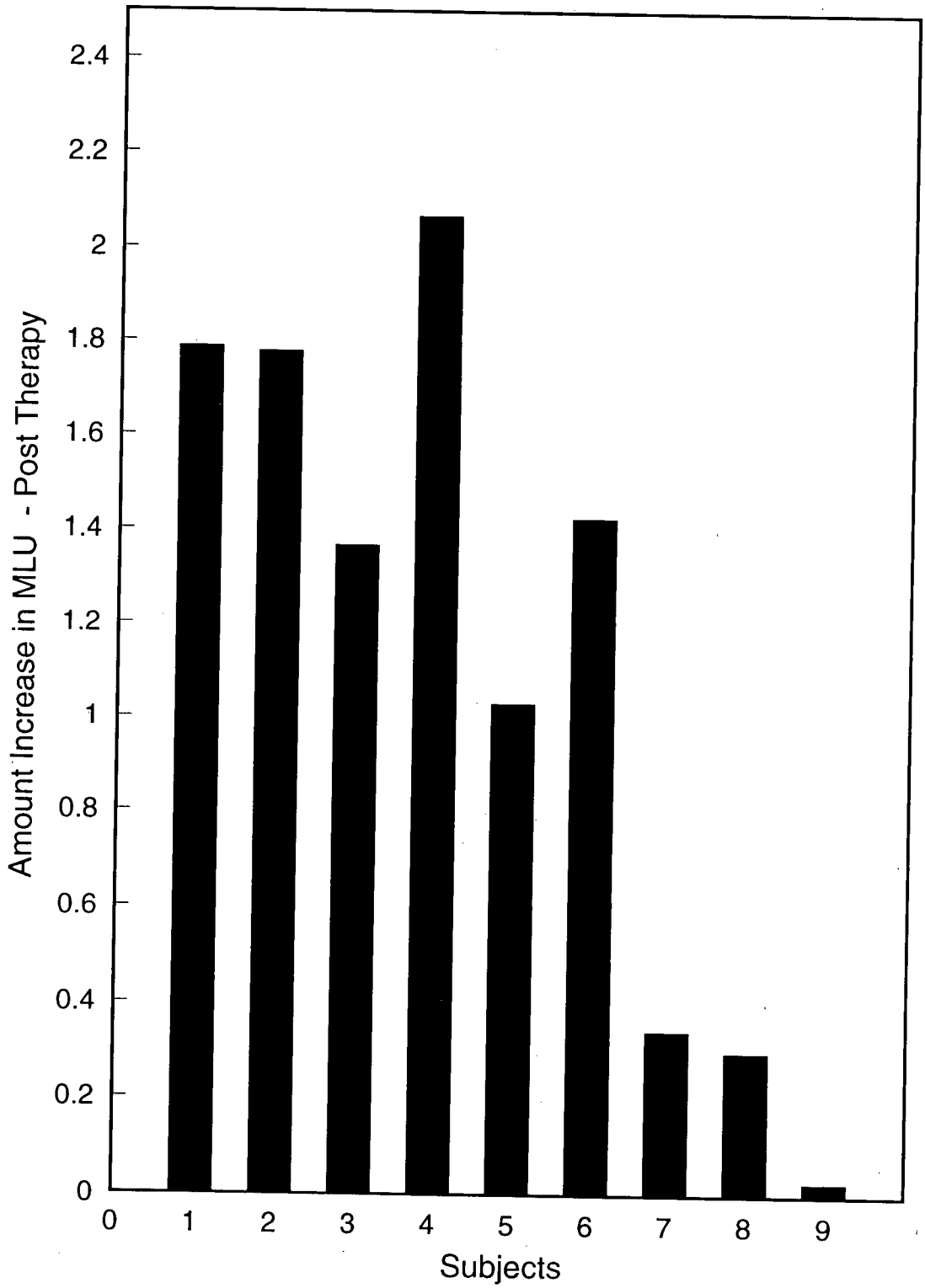

Figure 3.3b. Amount increase in Mean Length of Utterance from Time 1 (pre-intervention) to Time 2 (post-intervention).

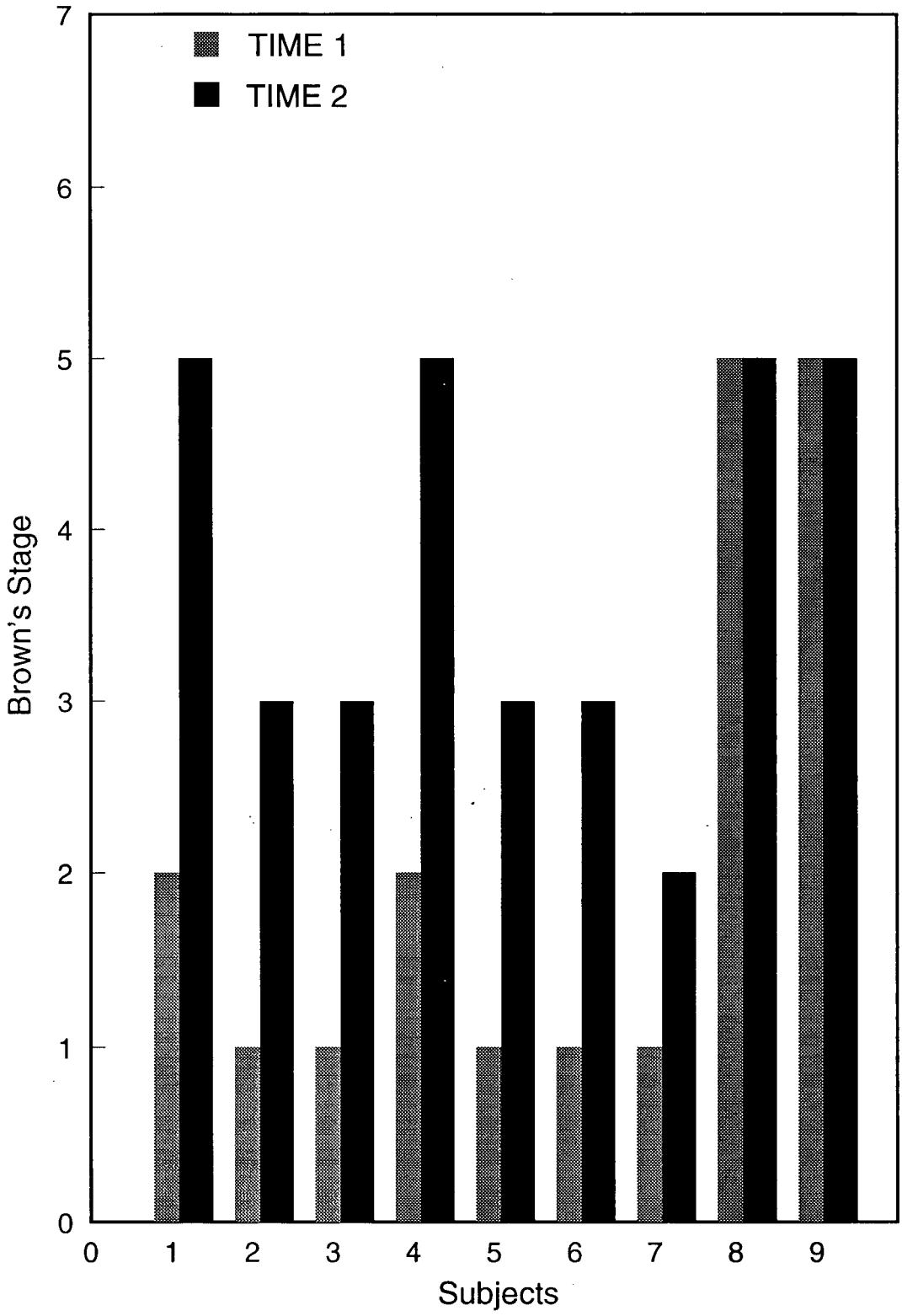

Figure 3.4. Brown's stage. Time 1 (pre-intervention) versus Time 2 (post-intervention).

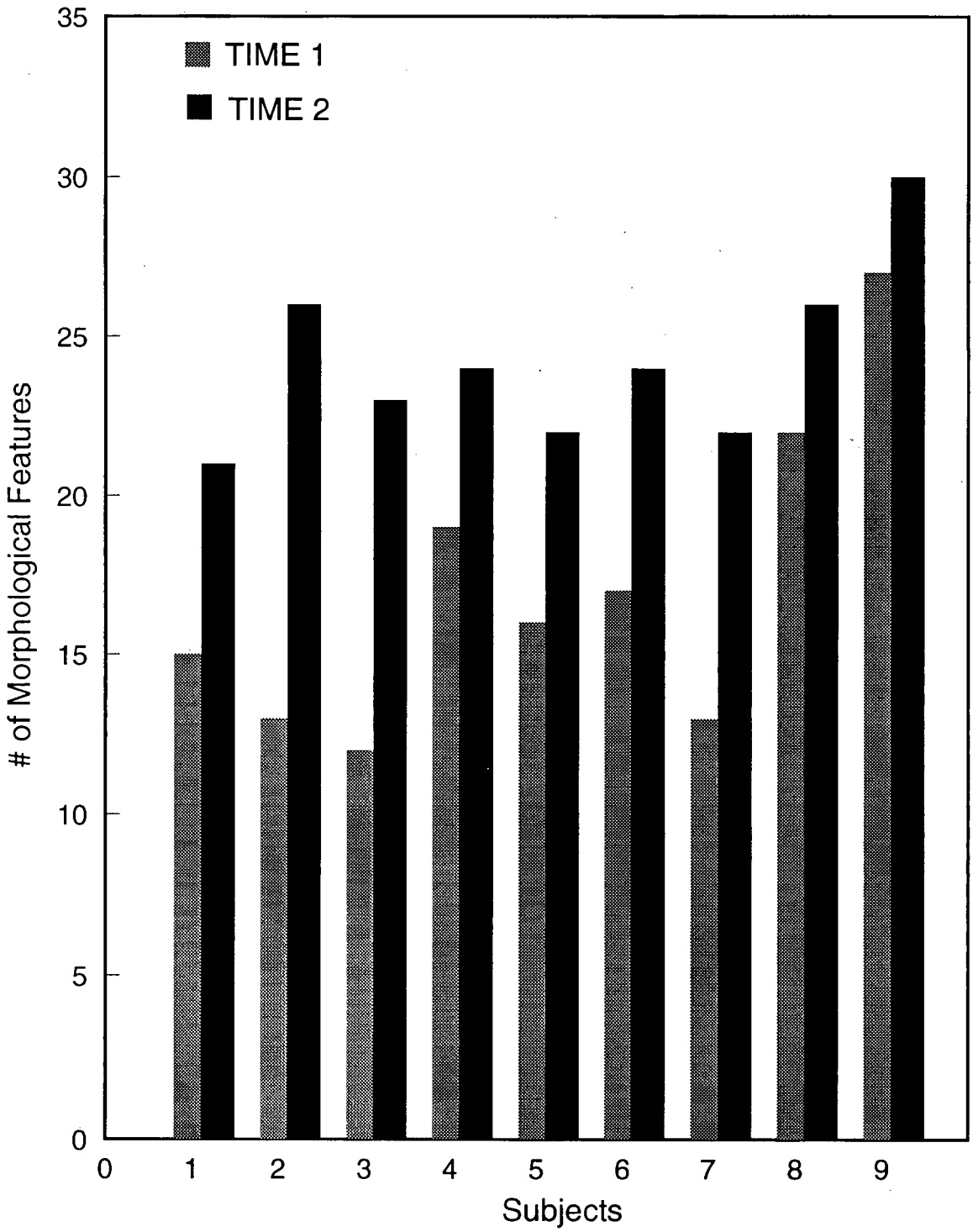

Figure 3.5. Number of morphological featurestypes present in subjects' inventory: Time 1(pre-intervention) versus Time 2 (post-intervention).

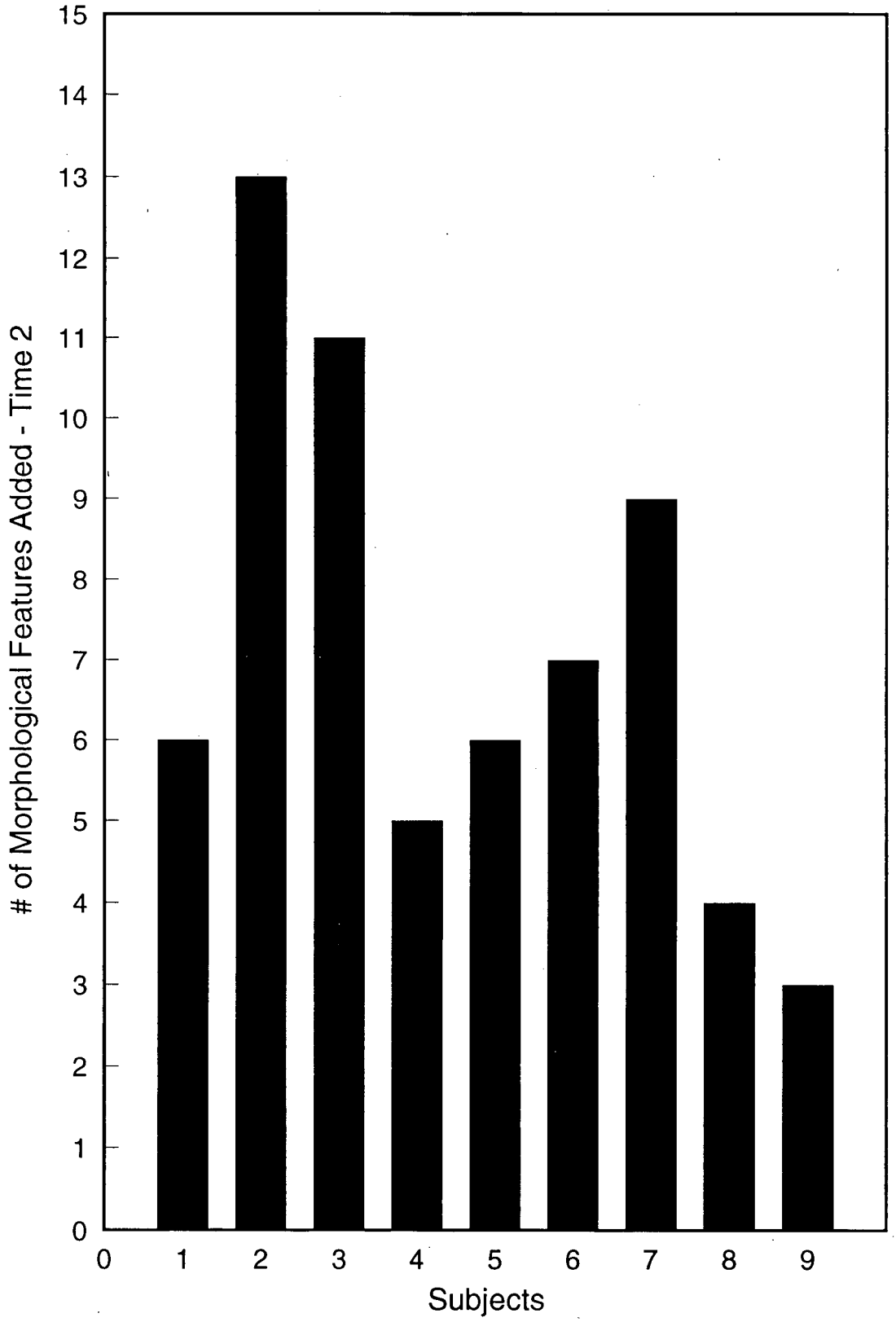

Figure 3.5b. Number of morphological feature types added to subjects' inventory at Time 2 (post-intervention).

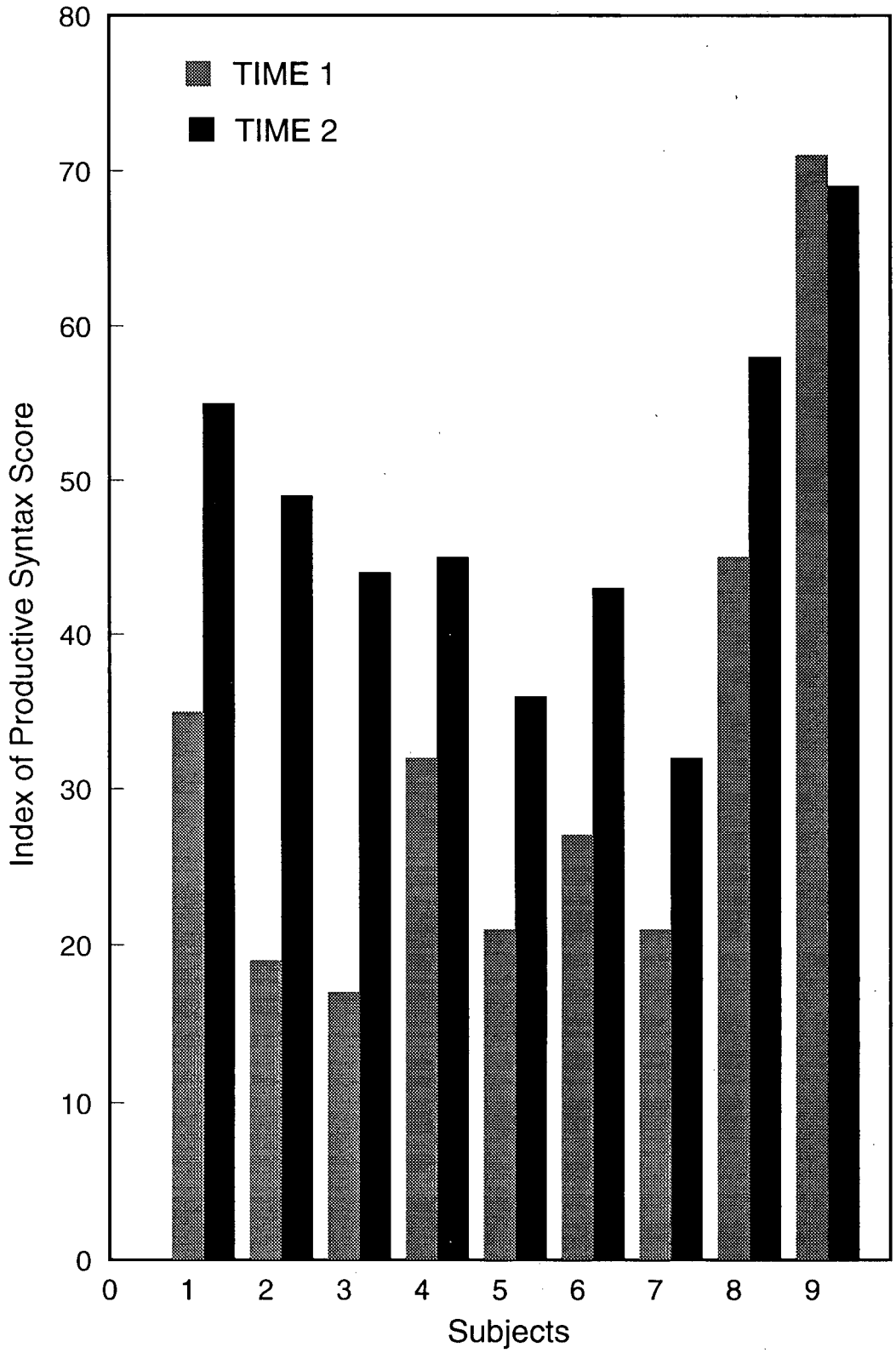

Figure 3.6. Index of productive syntax score: Time 1 (pre-intervention) versus Time 2 (post-intervention).

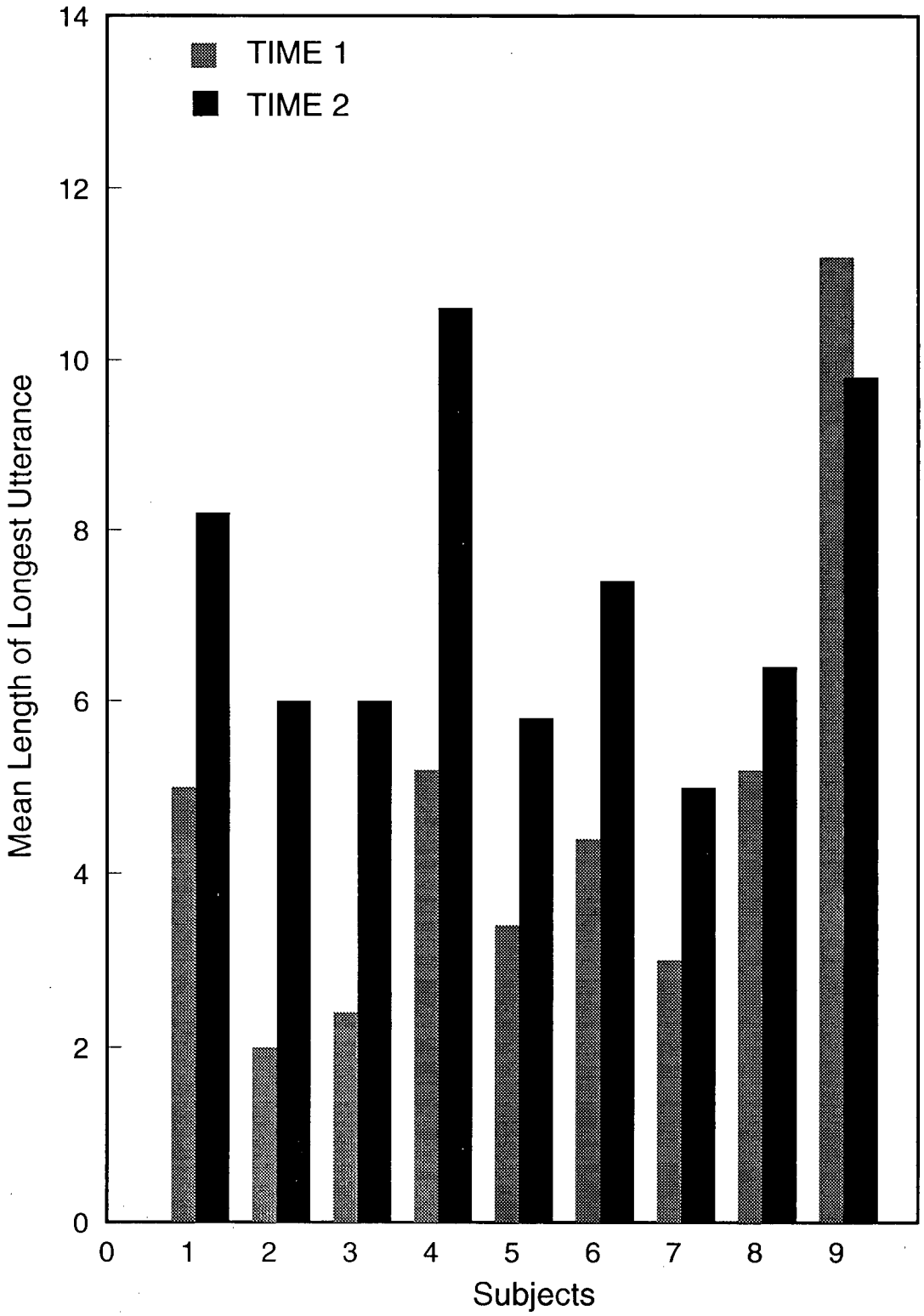

Figure 3.7. Mean Length of Longest Utterance (MLUL): Time 1 versus Time 2.

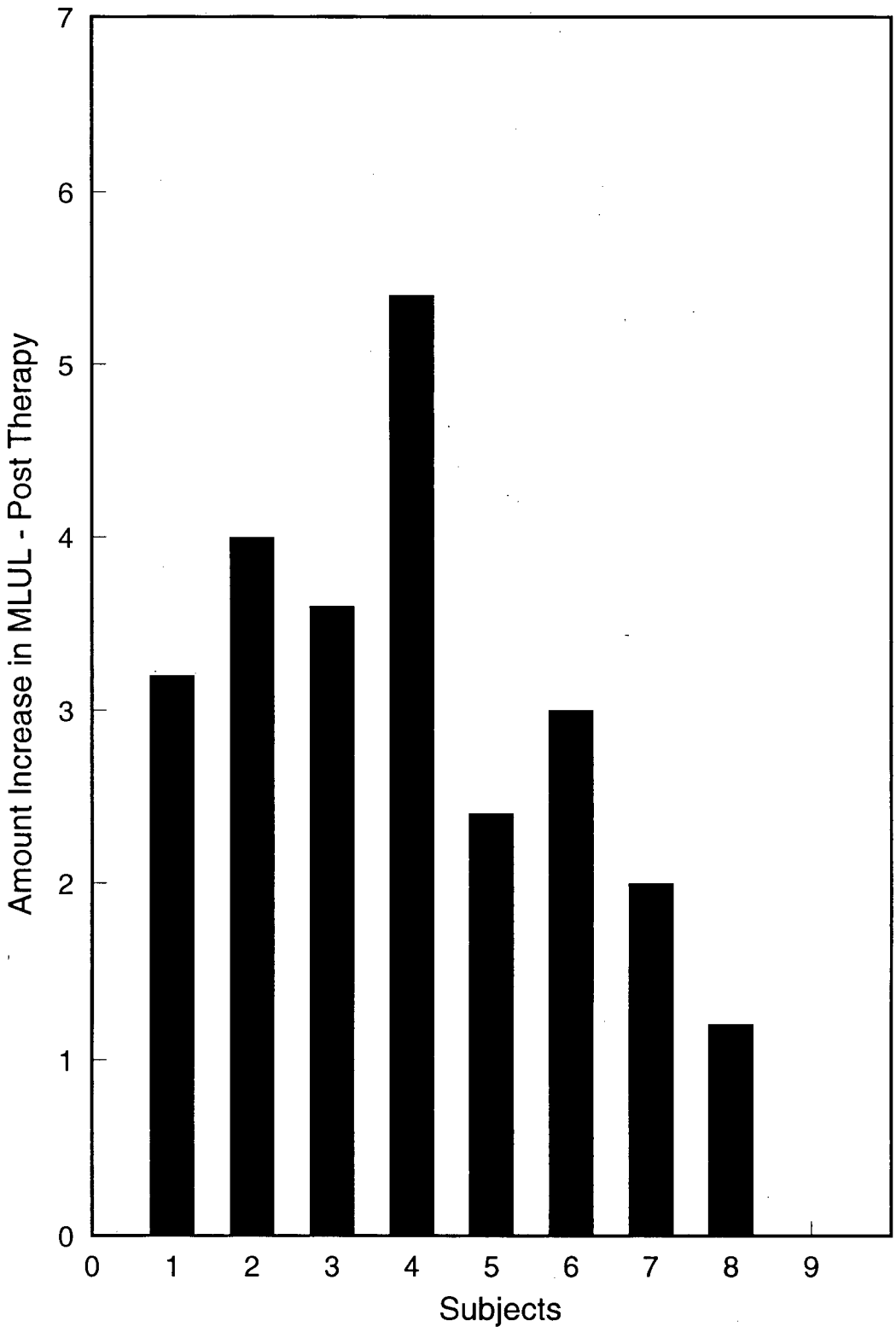

Figure 3.7b. Amount increase in Mean Length of Longest Utterance (MLUL) at Time 2 (post-intervention).

reference controls were isolated from the experimental group for these analyses. The Sign Test was first conducted on these measures. The null hypothesis states that there will be no significant improvements in the measures from Time 1 to Time 2 for both the experimental and reference control subjects. For the experimental group, the null hypothesis is rejected (Experimental: H: $M_D = 0$ vs. K: $M_D > 0$; $S_+ = 7$ $P(S_+ \geq 7) = 0.0078$). However, because of the small $\underline{n}$ in the reference control group there is not enough evidence to reject H for them. The two reference control subjects, however, did not show improvements and since they did not display a morphosyntactic production disorder at the onset of the study, no improvement is expected. Figures 3.3 and 3.3b display clearly that subjects 8 and 9 (control reference) do not display any dramatic improvements in their MLU scores between pre- and post- therapy measures. Figures 3.4, 3.5, 3.5b, 3.6, 3.7, and 3.7b show no or minimal improvement for these subjects in assigned level of morphosyntactic development.

The Wilcoxon Signed Rank Test was also conducted on all morphosyntactic production measures except Brown's Stage (the Wilcoxon assumes that all variables are continuous) to examine further morphosyntactic production development. The results were consistent with those of the Sign Test: All seven experimental subjects displayed significant improvements in their morphosyntactic production measures, whereas the two reference control subjects appeared not to have done so (Experimental: $T_+ = 28$, $T_- = 0$, $P(T_+ \geq franc(n + 1)4) = 0.008$).

The Kruskal-Wallis Test was performed on the morphosyntactic measures in order to examine whether the improvement observed for the reference controls was significantly greater than that of the experimental subjects. In other words, do the experimentals and controls behave similarly on the morphosyntactic measures after therapy? This test was not performed on the IPSyn measures as the reference control subjects did not fall at the extremes of the rankings and thus, this one-sided test would not have been able to accurately analyse this data. The test is performed on the ranked differences at Time 1 and Time 2 respectively and the null hypothesis is assumed to be chi-square, with degree of freedom = 1. The null hypothesis states that the experimental and control subjects perform equally on the morphosyntactic measures after therapy. The findings are as follows for the measures of MLU, Number of Morphological Features, and MLUL: H: $M_e = M_c$ vs. K: $M_e \rangle M_c$, $R_1 = 6$, $R_2 = 1.5$, $R = 5$, $H \sim X^2_1$, $P(X^2_1 \geq 4.2) =$ P- value, P-value $\approx$ 0.03. These results indicate that H is rejected. Thus, the scores of MLU, Number of Morphological Features produced, and MLUL from the experimental subjects are considered to be significantly different from those of the reference control subjects after therapy.

Correlations

The second question is: Are gains in phonology (as measured by PCC and PWM) correlated with gains in morphosyntax (as measured by MLU, IPSyn, Brown's stage, Number of Morphological Features produced, and MLUL)? In order

to know if there is any relationship between the gain in phonology and the gain in grammar, the *degree of association* has to be found. For this analysis the strength of the relationship between the pairs of each phonological measure with each morphosyntactic production measure is found. This measure of association between paired samples is called *Coefficient of rank correlation.* The results of relative degree of association are summarized in Table 7. According to this test, the gains in PCC are positively associated with the gains in both IPSyn and Number of Morphological Features but not with gains found in MLU or MLUL. In addition, the gains in PWM are found to correlate positively with the gains found in Number of Morphological Features only. Thus, as the scores in PCC and PWM increased, so did those of the measure, Number of Morphological Features, and as the PCC scores alone increased, so did those of the measure, IPSyn. The remaining morphosyntactic measurements were not significantly correlated with the increases observed in PCC and PWM.

Summary of Results

In examining the first question addressed in the present study: "Does phonological intervention lead to gains in morphosyntactic development for children severely impaired in both phonological and syntactic production?," the following results were found: (a) All of the nine subjects displayed significant improvements in the phonological production measures of PCC and PWM. (b) All seven experimental subjects combined showed significant improvements in their measures

Table 7. Correlated gains in phonological and morphosyntactic production

		Morphosyntactic Measures			
		MLU	IPSyn	#MF	MLUL
Phonological Measures	PCC	- 0.26	0.51	0.72	- 0.18
	PWM	- 0.38	0.11	0.63	- 0.10

of morphosyntactic production; MLU, IPSyn, Brown's Stage, Number of Morphological Features, and Length of Longest Utterance. (c) Although significant improvements in the measures of morphosyntactic production have been found from the experimental subjects, their post-therapy scores in MLU, Number of Morphological Features produced, and MLUL continue to be significantly lower than those of the reference control subjects.

In examining the second question addressed in the present investigation: "Are the gains in phonology (as measured by PCC and PWM) correlated with the gains in morphosyntax (as measured by MLU, Brown's stage, IPSyn, Number of Morphological Features Produced, and MLUL) for children with severe phonological and morphosyntactic production disorders?," the following results were found: (a) gains in PCC were positively correlated with gains in IPSyn and Number of Morphological Features produced and, (b) gains in PWM were positively correlated with gains in Number of Morphological Features produced.

CHAPTER FOUR

DISCUSSION

Overall Findings

The present study examined the effects of nonlinear phonological intervention on the development of morphosyntactic production in preschool children severely impaired in phonology and syntax. Specifically it asked whether nonlinear phonological intervention leads to gains in syntactic development for this population of children and whether the gains found in their phonological measures were correlated with the gains found in their morphosyntactic measures. It was hypothesised that an intervention which focuses solely on treating the phonological production deficit would have significant effects on development of morphosyntactic production.

Subjects were nine preschool children. Seven had severe phonological and syntactic production disorders (experimental group) and two had only a severe phonological disorder (reference control subjects). Each subject and a parent participated in nonlinear phonological intervention for 16 to 18 weeks.

The overriding null hypothesis stated that phonological intervention would not lead to gains in morphosyntactic production development and that gains in phonological production measures would not correlate with the gains in morphosyntactic performance measures for the seven experimental subjects. The findings in the current investigation led to a rejection of the null hypothesis. First, nonlinear phonological intervention did appear to affect the development of phonological production. The Sign and the Wilcoxon Signed Ranks tests displayed

significant differences for all nine subjects' phonological measures between Time 1 and Time 2. Second, nonlinear phonological intervention appeared to affect the development of morphosyntactic production. The Sign and Wilcoxon Signed Ranks tests displayed significant improvements in the measures of morphosyntactic production for all seven experimental subjects. Although all seven experimental subjects displayed significant gains in their morphosyntactic production, their post-therapy morphosyntactic scores are not considered to be similar to those of the reference controls as the Kruskal-Wallis test indicated. The reference control subjects appeared to display no or minimal improvements in their assigned levels of morphosyntactic development. Since they did not display a morphosyntactic production disorder at the onset of the study, no improvement was expected.

Overall, the experimental subjects who were severely impaired in both phonological and syntactic production did show significant gains in both linguistic domains after nonlinear phonological intervention, more than would be expected by maturation. Maturational data, based on the associated age-levels of MLU and Brown's stage [Miller, 1981], predicts that the experimental subjects should have progressed an average of 0.62 in MLU and 1.14 stages in Brown's stage over the average 6.6 month time frame in the current investigation. The experimental subjects, however, progressed an average of 1.40 in MLU and 2.29 stages in Brown's stage over this 6.6 month time frame. Thus, on both the measures of MLU and Brown's stage the experimental subjects progressed more than twice as much as was expected by maturation for their age level. In addition, when examining maturational data based on the actual MLU score over the average 6.6

month time frame, the experimental subjects again displayed a greater progression rate than would be predicted. In other words, according to Miller (1981) typically developing children with an MLU of 1.79 should progress on average to an MLU of 2.60 in a 6.6 month time frame (a progression of 0.81 in MLU). However, the experimental subjects who displayed an average MLU of 1.79 at Time 1 progressed to an average MLU of 3.19 at Time 2 (a progression of 1.4 in MLU).

Although nonlinear phonological therapy does appear to have an effect on morphosyntactic development for children severely impaired in both phonology and syntax, it does not appear to have such an impact on children who are severely impaired in only the domain of phonological production. The control reference Ss, S8 and S9, did not display any apparent gains on the measures of morphosyntactic production used (refer to figures 3.3 thru 3.7b), while they did display significant gains in their measures of phonological production (refer to figures 3.1 and 3.2).

In terms of the relationship between phonology and morphosyntax, it was found that for all seven experimental Ss the gains in PCC were positively correlated with the gains in both IPSyn and Number of Morphological Features but not with gains found in MLU or MLUL. Furthermore, the gains in PWM were found to positively correlate with the gains found in Number of Morphological Features. Therefore, it is concluded that there is some association between the two production domains of phonological and morphosyntactic development. As the scores in PCC and PWM increased so did those of the morphosyntactic measure Number of Morphological Features, and as the PCC scores alone increased, so did those of the syntactic measure IPSyn. The remaining morphosyntactic

measurements were not significantly correlated with the increase in phonological measaments. Overall, the findings of the present study suggest that nonlinear phonological therapy leads to gains in morphosyntactic prroduction development for only those children severely impaired in both domains of phonological and syntactic production. In addition, there is some evidence of a positive association between the production domains of morphosyntax and phonology. These conclusions and their association to past research, along with an in-depth examination of the relationship between the domains of phonological and morphosyntactic production, will be examined further following a more extensive analysis of the phonological and syntactic results.

The Development of Phonological Production

Nonlinear phonological therapy significantly affected the phonological production development of all nine subjects. S4, S5 and S6, however, appeared not to make large gains in their overall PCC and in the case of S5 and S6, their PWM scores. These subjects' intelligibility ratings were thus examined further. First, examination of S4's data revealed that, although she made minimal gains in her total PCC score she did make greater gains in her PCC scores for initial consonant within word (IC) position (27% - 13% at Time 1 to 40% at Time 2) and she also began producing the final consonant within word (FC) position (0% at Time 1 to 14% at Time 2). In addition, her PWM more than doubled (from 14% at Time 1 to 30% at Time 2 - refer to figure 3.2). Thus, it appears that although S4

did not gain dramatically in PCC, she did improve in phonological development. Her intelligibility improved through her ability to match the targeted prosodic structure of a word, as demonstrated in her improved PWM score and her increases in correct productions of IC and FC word positions. Examination of S5 also revealed minimal change in PCC scores. However, this subject's PCC scores for word-initial (WI) position increased by 12% (41% at Time 1 to 53% at Time 2) and she began to produce word-final (WF) consonants (0% at Time 1 to 7% at Time 2). In addition, she added a total of seven segments to her phonetic inventory. Thus, it seems that her intelligibility improved through her improved productions of WI and WF positions and her ability to produce a wider variety of phonological segments. Subject 6 also displayed minor improvement in his phonological measures. He did, nevertheless, increase his PCC for WI position by 10% (58% at Time 1 to 68% at Time 2) and began to produce the FC position (0% at Time 1 to 6% at Time 2). Furthermore, he added six new segments to his segmental inventory. Therefore, phonological production improved through development in the WI and FC word positions and his increased ability to produce a greater variety of phonological segments. Overall, although not readily apparent in all nine of the subjects' phonological measures, significant improvement in phonological production was made as a result of nonlinear phonological intervention.

Development of Morphosyntax

Significant improvements were also observed for all seven experimental

subjects in morphosyntax. However, S7 displayed minimal improvements in the syntactic measures MLU and IPSyn. Upon examination of this child's initial language sample, it was found that he often produced nasal filler syllables such as [n]. Bernhardt and Johnson (in press) analysed the production of these filler syllables. They concluded that filler syllables indicated an underlying knowledge 'of the serial ordering of sentences in English, and the need for a variety of grammatical constituents' (p.27). In other words, the fillers appeared to function as words, although there seemed to be no single word interpretation for the fillers. The percentage of utterances containing these filler syllables was reduced by almost half between Time 1 and Time 2 of the present study (46.3% at Time 1 to 24% at Time 2) (Bernhardt & Johnson, in press). Thus, the IPSyn score and MLU may not have been sensitive to the changes occurring in this child's sentence structure. S7 seemed to be decreasing his use of fillers and increasing his use of real words instead of developing his phrase structure and word combinations.

Overall, all seven experimental subjects severely impaired in the domains of phonological and morphosyntactic production displayed significant gains in their production of syntax as a result of the nonlinear phonological intervention. The two reference controls, impaired in only the domain of phonological production did not show such gains, however (figures 3.3 to 3.7b indicate the minor gains showed). Since these subjects were not impaired in the domain of morphosyntactic production at Time 1, no improvements were expected. Thus, it is concluded that when both domains of phonological and syntactic production development are severely disordered there is an interaction between the two

domains, whereby intervention in the domain of phonology can result in development in the domain of morphosyntactic production.

The experimental subjects development in the domain of morphosyntactic production, however, does not appear to advance to the level of the control reference subjects. This result indicates that perhaps more therapy is needed in the area of morphosyntax for the experimental subjects.

Comparisons with Previous Studies

The conclusion that there is an interaction between the domains of phonological and morphosyntactic production calls into question the statement given by Fey et al. (1994) that 'there is a great deal of independence between the development in grammatical and phonological production' (p. 603). The findings of their study led to this conclusion: that language-based therapy had no impact on the development of phonological production for preschool children with a severe morphosyntactic delay and moderate-profound phonological delay. The findings of the present study, however, suggest that the two domains of phonology and morphosyntax are not independent of one another. In fact, it is hypothesized that the relationship between these two linguistic domains can be influenced by phonology for prescool children severely impaired in phonological and morphosyntactic production. In other words, when both domains of syntactic and phonological production are severely disordered, the deficient phonological system can impair the child's output more than the disordered syntactic system. Tyler and

Watterson (1991) and Tyler and Teipner-Sandoval (1994) both found moderate effects of phonological intervention on the development of morphosyntactic production. Their findings led to conclusions that there is an interaction among the linguistic domains of phonology and syntax. As mentioned, however, their results were insignificant and thus, they concluded that the interactions could be related to both treatment focus and severity type. The issues of severity level and impact of nonlinear phonological intervention as they relate to the interactions among the production domains of phonology and syntax is addressed in upcoming sections.

Currently there are three major models that could offer an explanation for the relationship between phonological and morphosyntactic production. These are (a) Garrett's (1984) model of production (the Top-Down perspective) , (b) Panagos' (1982) model of production (the Top-Down and Bottom-Up perspective), and (c) Stemberger's (1985) Parallel Interactive Activation model of production (an interactive perspective). These models will each be discussed and how they relate to the findings of the present investigation will be examined. As mentioned in the introduction, each subject's competence in language is assumed to be intact. The results of the standardized language comprehension assessment tests (summarized in table 2) appear to be consistent with this assumption as all nine subjects fall within the limits of their age range.

Garrett's (1994) Model of Production

Garrett's model of production predicts that syntax can affect phonology or

the two domains can be mutually inhibitory at the positional level, but phonology can never have a solely unidirectional effect on syntax (refer to figure 1.1). Thus, a therapy program focussing exclusively on facilitating phonological development should not promote development in the syntactic domain. The findings of the present investigation, however, cast doubt on this latter prediction. The nonlinear phonological intervention did promote gains in the area of productive language development for children severely impaired in both phonological and morphosyntactic production. Therefore, it appears that although Garrett's model can account for the relationship between phonology and syntax for children impaired in only syntactic production (the reference controls), it does not accurately depict this relationship for children severely impaired in both of these productive linguistic domains (the experimentals). This Top-Down perspective, with syntax governing phonology, may not be sufficient to explain the relationship between phonology and syntax as it does not account for all variations of disorders. Therefore, the Bottom-Up perspective, with phonological processing impacting upon syntactic processing, is examined.

Panagos's (1982) Model of Production: Top-Down and Bottom-Up

Panagos (1982) states that for children with both phonological and syntactic deficits, a disruption in phonological production can cause and/or contribute to a syntactic production disorder. His model proposes a bidirectional (Top-Down and Bottom-Up) influence on children's sentence productions, with each linguistic

domain (phonology and syntax) affecting the other. The phonological and syntactic components are encoded simultaneously, with each level being simplified in its own right and each level influencing the simplification of the other. This type of model predicts that phonological intervention could lead to improvement on the encoding of phonological form. This improved encoding could in turn reduce the simplification of syntactic structures and result in syntactic gains. The improvement in syntactic structures hypothesized in this model is proposed to result from the child being a more active participant in the communicative process. By producing more intelligible speech, the child can be better understood and as a result receive more appropriate feedback from the adult, which promotes morphosyntactic production development. The improvement observed in the domain of morphosyntactic production for the seven experimental subjects in the current investigation, according to this model, then, is a result of the increasing amount of appropriate syntactic feedback they receive from the adult. The position that more intelligible children receive more appropriate modelling of adult language forms does not fully take into account the interactive relationship of the two linguistic domains in terms of processing.

Parallel Interactive Activation Model of Production: Stemberger (1985)

Stemberger (1985) offers a parallel processing model in which there is an interaction between the syntactic and phonological processing levels of production. Activation at the lexical level, for instance, causes activation to the linked

phonological level. The associated phonological units (e.g., features, segments, syllable patterns etc.) are triggered and in turn feed back up to the lexical level reinforcing the activation of the original lexical unit. This lexical unit activated thus gets "richer and richer" from the reinforcement of the associated phonological units resulting in the lexical item being chosen for production. A disordered phonological system could result in inappropriate or insufficient phonological units being activated. The feedback from the deficient phonological level to associated levels (e.g. Lexical and Syntactic) thus may not be reinforcing but inhibitory. The result would be that the appropriate lexical items or syntactic structures are not produced.

The nonlinear phonological intervention implemented in the present investigation targeted the phonological level (e.g. features, syllable patterns, etc). As mentioned in the introduction, children who do not produce the specified feature and syllable forms can substitute these forms with their defaults (e.g., CV structure or [- continuant], yielding stops). This default form provides inappropriate feedback to the syntactic level. Therefore, by improving the seven experimental subjects' abilities to activate the appropriate phonological units, reinforcement was given to the associated levels of Syntax and the Lexicon. Hence, the reinforced lexical and syntactic structures required were produced. This intervention process goes beyond improving the surface-level dependencies between the syntactic and phonological form (such as, the ability to produce word-final consonants in order to produce a variety of morphosyntactic inflections in English), and the result is development in morphosyntactic productions not directly targeted in therapy. For instance, both Number of Morphological Features produced and the IPSyn scores

correlated positively with the phonological production measure of PCC. In other words, the phonological production goals for these seven subjects were not, for instance, based on facilitating the production of word-final /s/ in order to produce plurals or possessives (refer to individual goals targeted -- Appendix A). Instead, the nonlinear therapy focussed on phonology per se (e.g., the features or the general syllable structure). Improving phonological production by targeting these internal levels resulted in more than just surface-level gains in language production. These children severely impaired in both phonological and morphosyntactic production improved their morphosyntactic performance in a variety of ways that were not targeted in intervention (see Tables 5 and 6). These morphosyntactic production improvements occurred simultaneously with improvements in phonological processing ability of the seven experimental subjects. According to Stemberger's (1985) model, children severely impaired in the domains of phonological and syntactic production could display gains in morphosyntactic production post-therapy because they were more readily able to activate the appropriate phonological units at the processing level. These activated phonological units in turn fed back up to and reinforced the lexical and syntactic units, which were in turn appropriately chosen for production. The Parallel Interactive Activation model of production (Stemberger, 1985) offers the most useful explanation as to the relationship between the domains of phonology and syntax for children severely impaired in both domains of phonological and morphosyntactic production. This model, however, does not completely explain the relationship between phonology and syntax for children only severely disordered in the domain

of phonological production (e.g., the two reference controls).

The issue with children severely impaired in only phonological production is that their disorder does not appear to impact upon their syntactic production. In other words, why do not all children displaying a severe productive phonological deficit have associated syntactic production impairments? In the case of the two reference control subjects in the present investigation, their severe phonological deficit did not appear to have any significant effect on their production of syntax. The Parallel Interactive Activation model in its present form may not fully account for this result. Thus, two hypotheses are proposed to account for these children: the interaction and effect of the lexical/semantic level and/or a syntactic filter system. In considering these hypotheses, it is important to remember that a competence, as opposed to a production explanation cannot be absolutely eliminated.

The Interaction of the Lexical/Semantic Level

The current investigation showed that only the seven experimental subjects with severe disorders in both phonological and syntactic production improved in morphosyntactic production as a result of phonological intervention. The control reference subjects, with only a severe phonological disorder, did not appear to display such improvements. Thus, the domain of syntax appears to be less affected by other levels of language production such as phonology when it is not disordered. In the case of the control reference subjects, the lexical/semantic and

syntactic levels are proposed to be strongly linked with only weak links to the disordered phonological level. Syntax is relatively unaffected by the disordered phonological system because these childrens' productions of underspecified phonological default forms are felt to contain meaning. These default forms can then be assigned syntactic structure on the basis of their meaning. Syntactic structure depends on meaning and thus, the control reference subjects were able to rely on the appropriate feed back from the lexical/semantic level to produce the appropriate syntactic forms. Phonological intervention thus, resulted in only minor improvements in syntactic production as these children, impaired in only phonological production, were not using the phonological system to assign syntactic structure in the first place.

On the other hand, the experimental subjects who were severely disordered in both domains of phonological and syntactic production are hypothesized to have had a weak link between their syntax and lexical/semantic levels and their phonological and lexical/semantic levels. Thus, they could not rely on the meaning of their underspecified phonological default productions when assigning syntactic structure. Hence, it is proposed that nonlinear phonological intervention promoted development in the domain of morphosyntactic production for two reasons: (1) more appropriate phonological feedback was being given to the syntactic level as, predicted by the model of Parallel Interactive Activation (Stemberger, 1985), and (2) improved phonological productions resulted in the production of more meaningful words. In turn these meaningful lexical items were assigned to appropriate syntactic forms. The overall result was a stronger link between the

lexical/semantic and syntactic levels which promoted morphosyntactic development. In other words, improved phonological production resulted in productions of specified phonological forms. These specified forms distinguished meaning and, therefore, could be placed into a syntactic frame.

The finding that after therapy the experimental subjects are not yet at the same level of morphosyntactic production as the reference controls may also relate to the "strength" of the link between the levels of syntax and lexical/semantics. For the experimental subjects, nonlinear phonological intervention appeared to strengthen the link between syntax and lexical/semantics indirectly via the level of phonology. Further morphosyntactic therapy may be required in order to directly and "fully" strengthen this link.

A second hypothesis to account for children with only a severe phonological disorder that has no apparent impact on their syntactic performance is the possibility of a productive syntactic filter system.

A Productive Syntactic Filter System

In the present study only the seven experimental subjects, with severe production disorders in both domains, showed improvement in morphosyntax. The reference control subjects, with only a severe productive phonological disorder, however, did not appear to display any significant improvements in their syntactic production. Thus, the domain of syntax appears to be less affected by other levels of language production, such as phonology, when it is not disordered. An

unimpaired productive syntactic system is more able to "stand-up" to the effects of an impaired phonological production system, whereas, an impaired productive system is not. A "healthy" syntactic production system is therefore proposed to act as a "filter." This filter is somewhat like the bucket theory of production (Crystal, 1987), according to which a disordered syntactic system is represented in the bucket of language as a level with "holes" in it. An extra drop of phonology may cause the overflow of a drop of syntax via the holes (Crystal, 1987). A "healthy" syntactic system in this bucket, however, would not have "holes" in it. Thus, any extra phonological influences would not affect syntactic production. With regard to the Parallel Interactive Activation model of production, when the syntactic production level is unimpaired, inappropriate feedback from the severely disordered phonological level is "filtered out" at the syntactic level and the result is unimpaired syntactic production. The associated phonological production domain does not have a great impact on the domain of syntactic performance. However, when the syntactic production level is severely impaired there is no syntactic "filter" system in place. Therefore, inappropriate feedback from the severely disordered phonological level affects and perhaps even contributes to a morphosyntactic production disorder. In the latter case, the phonological production domain does have a significant impact on the domain of syntactic performance, but only if there is a severely impaired syntactic production system (i.e., morphosyntactic production is severely impaired). The present findings could be explained by the existence of a productive syntactic "filter" system. The experimental subjects, who exhibited both severe phonological and

morphosyntactic production disorders, were found to improve significantly in their syntactic performance as a result of phonological intervention. This result reveals that for children severely impaired in phonological and morphosyntactic production, their disordered phonological production was affecting their development of syntactic production. The severely impaired syntactic level was not able to "filter" out the inappropriate feedback from the severely disordered phonological level. Thus, therapy promoted positive changes in phonology which sent activating information to the syntactic level. The reference control subjects, who exhibited only a severe phonological production disorder, on the other hand, did not appear to improve in their morphosyntactic performance as a result of phonological therapy only. Therefore, for children severely impaired in only phonological production, it appears that their disordered phonological system was not affecting their production of syntax. The unimpaired syntactic level instead acted as a "filter" to "weed out" any inappropriate feedback from the severely disordered phonological level.

The finding that the post-therapy morphosyntactic measures for the experimental subjects were considered to be significantly different from those of the reference controls (i.e., the experimentals were still not up to the level of morphosyntactic production as the reference controls) could relate to the possibility of a syntactic "filter." It could be that nonlinear phonological intervention was only able to improve the feedback from the phonological level to the syntactic level, promoting activation of the appropriate syntactic forms and resulting in morphosyntactic development. However, the syntactic level itself was perhaps not

"strengthened" enough and, thus, further morphosyntactic intervention may be required in order to aid the child to "construct" such a "filter" system.

The Issue of Severity Level

Both the syntactic filter system and the influence of the lexical/semantic level are proposed to offer an explanation for the differentiating results found in Tyler & Watterson (1991) and Tyler & Teipner-Sandoval (1994). These studies found only moderate or insignificant effects of phonological therapy on the development of morphosyntactic production in children impaired in both phonology and syntax. In both studies subjects' displayed less severe and moderately-severe syntactic production disorders (Tyler& Watterson (1991) and Tyler & Teipner-Sandoval (1994) respectively). First, the lexical/semantic interpretation may offer some explanation for the insignificant results found in both of the Tyler studies. Children with only moderately-severe syntactic production disorders are perhaps able to assign more meaning to their (fewer) underspecified phonological default productions. Thus, they may have a stronger link between their syntactic and lexical/semantic production systems than children with severe syntactic production disorders. The result of this stronger link would mean that for children only moderately impaired in syntactic production, improvements in morphosyntactic development would not be dramatic. In other words, even before phonological intervention these children were already able to assign some syntactic structures via meaning at the lexical/semantic level.

A second explanation for the insignificant results found in the Tyler studies is hypothesised to be the existence of a syntactic filter system. This "filter" system is proposed to be at least partially represented at the level of syntactic processing during pre-therapy assessment. The effect of this partial "filter" system at the syntactic level is that some inappropriate feedback from the disordered phonological level is already being "filtered" out.[5] The impact then of phonological intervention is less significant than it would be if no syntactic "filter" system were present, as with a severe impairment in morphosyntax. The results found in these studies relate more to the findings of control reference subjects in the present study. In the current investigation, the children who had only severe phonological disorders did not appear to show morphosyntactic gains as a result of phonological intervention. Their syntactic level of processing was already "strong" enough to filter out the inappropriate phonological feedback. Therefore, improving this feedback through intervention had no significant effects. Overall, in the cases of the Tyler & Watterson (1991) and Tyler & Teipner-Sandoval (1994) studies, improving the feedback from the phonological level through phonological intervention had only moderate effects. For these subjects at the initial point of assessment either some syntactic structures were already being assigned by meaning through the lexical/semantic level or some inappropriate information from the phonology level was already being disregarded. Thus, the gains of the Tyler &

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[5] The concept of a filter system may be likened to Crystal's (1987) bucket theory of language production. The syntactic level in the bucket would be considered intact (i.e., have no "holes") and thus, extra phonological information would not cause any syntactic information to "spill" out.

Watterson (1991) and Tyler & Teipner-Sandoval (1994) subjects were not as dramatic as the gains made by the experimental subjects in the present investigation, who did not have either a strong link between their levels of syntax and lexical/semantic and/or any filter system in place during pre-therapy assessment.[6]

The Impact of Nonlinear Intervention: Prosodic Influences

The positive effect of nonlinear phonological therapy on morphosyntactic production is hypothesized to result from the type of goals and methods used. This type of intervention focuses separately and equally on features and prosodic structures. Past research has found that the ability of a child to plan articulations over larger linguistic units governs the onset of multi-word combinations (De Villiers & De Villiers, 1978; Watterson, 1978; Branigan, 1979; Donahue, 1986; Matthei, 1989). Phonological and morphosyntactically impaired children thus, may be held back in their development of syntactic production because of their inability to construct well-formed syllables. For instance, in English codas and word-final clusters carry much morphosyntactic information. Furthermore, free grammatical morphemes are usually found in unstressed position. Gerken (1991) found that

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[6]Note that explanation for the differences between this study and that of Tyler & Watterson (1991) and Tyler & Teipner-Sandoval's (1994) findings relates to the type, duration, and focus of intervention. In the present investigation, the 16 to 18 weeks of nonlinear phonological intervention possibly had a significant impact on the resulting morphosyntactic production development found for the seven experimental subjects.

preschool children tend to omit weakly stressed syllables in English, including pronouns and other morphemes, particularly from iambic (weak-strong) feet. Nettlebladt (1983) even hypothesized that the ability to chunk syllables together into polysyllabic words may parallel the ability to chunk words together into phrases. Hence, the ability to produce the appropriate prosodic structure appears to have a direct influence on the development of morphosyntactic production. A solely syntactic or phonological explanation to describe preschool childrens' omissions of grammatically specified elements may not be appropriate (Gerken, 1991). Morphosyntactic omissions, instead, may be linked to processes that occur at the word level (Gerken, 1991).

Nonlinear phonological intervention focuses directly on the word level and aids children in producing the appropriate syllable structures which in turn results in the development of morphosyntactic production. Subject 4 offers a good example of this process. This subject made little gains in her overall PCC score (see figure 3.1). However, upon examination, it was revealed that she more than doubled her ability to match the targeted adult wordshape (PWM - 14% at Time 1 and 30% at Time 2 - see figure 3.2). In addition, her ability to produce the Initial Consonant within word (IC) position improved by 27% and she began to produce the Final Consonant within word (FC) position 14% by the time during her post-therapy assessment. Overall, this subject improved her intelligibility rating not through dramatic increases in her percentage of consonants correct but in her improvements in PWM and her correct productions of the IC and FC word positions. Thus, the significant gains found in her morphosyntactic production measures (refer to figures

3.3 to 3.7b) appeared not to result from improved phonological productions (overall PCC gains) but rather from her increased ability to construct a syllable or a word.

Summary

Nonlinear phonological intervention was found to accelerate significantly the development of phonological and morphosyntactic production in seven children severely impaired in both phonological and syntactic domains. Nonlinear phonological intervention targeted not only the feature level of the subjects' productions, but also syllable and word structure. As a result, these subjects were better able to: (1) produce the appropriate phonological features which promoted positive/reinforcing phonological and lexical/semantic feed back to processing level of syntactic production and (2) produce the appropriate prosodic structures so that they were able to construct more well-formed syllables and in turn construct more well-formed phrase structure. Thus, it is concluded that for the children severely impaired in phonological and morphosyntactic production, their syntactic omissions displayed pre-therapy were a result of processes that occurred at two levels: (1) at the level of processing, and (2) at the level of the word (the ability to construct a well-formed syllable).

At the level of processing, for children severely impaired in both phonological and morphosyntactic production, inappropriate feedback from the disordered phonological level seems to inhibit the activation of the required syntactic and lexical units for production. In addition, it appears that although

both phonology and syntax have an effect on one another at the processing level, when both production domains are severely disordered, a disordered phonological system has a greater influence on the resulting syntactic output than the syntactic processing has on the phonological output. Thus, phonological intervention has more of an influence on the development of the syntactic/morphological production domain than syntactic intervention has on the development of the phonological production domain. The findings of the present study support the latter statement as do the findings of Fey et al. (1994). The present investigation found a positive effect of phonological facilitation on morphosyntactic production, while Fey et al. (1994) found no positive effect of morphosyntactic facilitation on phonological production.

The severity level of the syntactic production disorder is also found to affect the gains found in morphosyntactic development as a result of phonological intervention. It is proposed that children impaired in phonological production and only moderately or unimpaired syntactic production do not display dramatic gains in morphosyntactic development. Before the onset of therapy these children were either: (1) already able to assign some or all syntactic structures via meaning at the lexical/semantic level and/or, (2) able to "filter" out the inappropriate information from the disordered phonological system.

The second influence of a severe phonological disorder on the development of morphosyntactic production is at the level of the word. The ability to produce the appropriate prosodic structure appeared to have a direct influence over the development of syntactic production. The seven experimental subjects not only

improved in number of segments produced (as evidenced in PCC scores) but also improved in their increased ability to produce the adult word and syllable shapes (as shown by the PWM scores). Their improved ability to construct a syllable and/or word enabled them to construct the morphosyntactic segments required in addition to increasing their overall MLU.

Limitations

Although the results of this study provided new and interesting issues regarding the relationship between the linguistic domains of phonology and syntax, there are limitations. First, this investigation did not provide sufficient experimental control through one-to-one matched controls (children with only a severe phonological production delay) to experimentals (children with both a severe phonological and morphosyntactic production delay). Only two reference controls were provided and thus with this small number no significance can be attributed to their outcomes. One-to-one matched controls as proposed would have been able to control for variables, such as maturation and familiarity, that may have influenced the results. For instance, the child may only be becoming more familiar with the clinician and thus, talking more, resulting in the appearance of morphosyntactic gains. Therefore, if the morphosyntactic development observed in a one-to-one control group was found to be significantly different from that of the experimental group, then one could have ruled out the influences of maturation and familiarity as potential causes for the gains found in morphosyntactic development in the

experimental group. Second, a larger sample size is needed to provide more reliable and valid results. Finally, in order to obtain a clearer picture of how the levels of processing in the production of language interact, children with only a disorder in syntactic production also need to be examined.

Implications for Clinicians and Future Research

The results of the present investigation have many interesting implications. First, they support previous findings by Tyler and Watterson (1991) and Tyler and Teipner-Sandoval (1994) that treatment in the domain of phonology can influence morphosyntactic development. Second, they provide at least partial explanation as to the issue of severity level and how it relates to the interactions found among the domains of phonology and syntax. Children who are severely impaired in both phonological and syntactic production can have gains in both of these linguistic domains through phonological intervention. Targeting only one domain in intervention can be a cost-effective and time-saving approach to therapy.

Further research should focus on the type and length of phonological intervention and its effects on the development of morphosyntactic production for children displaying various severity levels of phonological and syntactic production disorders. The 16- to 18- week nonlinear phonological intervention which directly targeted both the feature and word level of production, promoted development in morphosyntactic production. Targeting both the feature and word level of production has been proposed to account for the positive effects of phonological

therapy on the development of morphosyntactic production. The relatively short[7] phonological treatments implemented in past research, however, have not directly focussed on the feature and word levels (Tyler &Watterson, 1991; Tyler & Teipner-Sandoval, 1994). Thus, their findings of only moderate gains in morphosyntactic production for children with only moderate or less severe disorders in both syntactic and phonological productions may have been more significant if their phonological interventions were longer and targeted the feature and word levels of production. Future research should attempt to clarify the relationship between the linguistic domains of phonology and syntax as they relate to both the type of intervention and the severity level of a child's syntactic and phonological disorders. Finally, additional investigation is needed to examine and test the models of production proposed in the present investigation. Future models must account for all possible combinations of disorders for both children and adults.

Overall, the results of the current study provide useful insight into the interaction among the linguistic domains of language production. For children severely impaired in phonological and morphosyntactic production time and money can be saved by targeting only one disorder through implementing nonlinear phonological intervention.

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[7] Tyler & Watterson (1991)- phonological intervention was held for 8 to 9 weeks, two times per week. Tyler & Teipner-Sandoval - phonological therapy was held for twelve weeks, two to three times per week.

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APPENDIX A

INDIVIDUAL GOALS

SUBJECT 1:

Block 1:

(1) PROSODIC:

(a) - Mapping of segments to weakly established wordshape.
Methods: Onset-Rhyme - Target CVCV with C2 focus on t/d, p,f.

(b) - Establish syllable/word shape.
Methods: Mora methods - Target - bimoraic syllables in the form of CVC with lax vowels, and CVV (diphthongs). C2 = s,k.

(2) SEGMENTAL:

(a) - Establish features for liquids [+consonant] - [+sonorant].
Method: Focus primarily on /l/ but also introducing /r/. WI position unless SIWW and WF improve notably in prosodic block.
(b) - Link Features - (+continuant) to (+voice).
Method: Targets: /z/, /v/, /ʤ/ WI position unless SIWW and WF improve notably in prosodic block.

Block 2:

(1) PROSODIC:

(a) -Mapping /s/ to initial position in CCV and CCVCV word shapes.
(b) -Establish syllable/word shape CVC.
Method: -Mora methods - Target - Bimoraic syllables in the form of CVC with lax vowels, and CVV (diphthongs). C2 = /s/, /k/. Diphthongs in closed syllables in (C)VVC word shapes, plus addition of /ɔl/. Addition of /v/ and /z/ word finally. Focus on generalization activities - sentence and conversational level.

(2) SEGMENTAL:

(a) -Establish features for liquids.
Method: Focus primarily on /l/ but also on /r/. WI and SIWW positions.
(b) -Link Features - (+continuant) to (+voice) - Targets - /ʤ/ - WI and SIWW positions.

Block 3:

(1) PROSODIC:

(a) CVC, CVCV, (CCV) as main word shape goals including all segments except liquids.

(2) SEGMENTAL:

(a) /l/. Method: oral-motor and awareness in WI position

SUBJECT 2:
Block 1:
(1) PROSODIC:
(a) -Establish VCV as target word shape, consonant = /s/, /ʃ/, and nasals.
Method: Mora method
(b) -Link CV and CVC word shapes. C1 consonants = /k/, /t/, /p/, and /b/ (lengthened aspiration).
Method: Onset-Rhyme

(2) SEGMENTAL:
(a) -Linking Goal - Features: Link Labial to [+continuant] (and [voice]), giving /f/ and /v/, WF position.
Method: Oral-Motor emphasis.
(b) - Establish Goal - Features - [+consonantal][+sonorant] for WF liquids /l/ and /r/.

Block 2:
(1) PROSODIC:
(a) - Establish VCV: Goals: to (1) establish a babbling singing type sequence of CV's (up to 4 syllables) with rhythm and song (2) use of C in onset position. Add /z/ to other consonants.
Method: Mora approach.
(b) Mapping of CV and CVC to get WI consonants.
Method: Onset-Rhyme

(2) SEGMENTAL:
(a) -Linking Goal - Features: Link Labial to [+continuant] (and [voice]), giving /f/ and /v/, WF position.
Method: Oral-Motor emphasis.
(b) - Establish Goal - Features - [+consonantal][+sonorant] for WF liquids /l/ and /r/.
Method: Awareness approach

Block 3:
(1) WI /l/ and /w/.
(2) WI /s/-clusters.
(3) Awareness of rhyming.

SUBJECT 3:
Block 1:
(1) PROSODIC:
(a) to decrease the use of default /s/ codas and increase the range of consonants realized in final position (CVC).
(b) to strengthen the disyllabic word shape (CVCV).
Method: Moraic:Targets- (a)WF /p/, and (b)SIWW /n/ following lax vowel /ɔɪ/.
Method: Onset - Rhyme: Targets - (a) WF /p/, (b) SIWW /n/ after vowels or diphthongs, and (c) SIWW /t,d/.

(2) SEGMENTAL
(a) - Feature: Target - WI /h/ (root node [+consonantal] and Laryngeal node (+spread glottis).
(b) - Feature: Target - WI /l/ - Root node [+consonantal]/[+sonorant], default Place node.

Block 2:
(1) PROSODIC:
(a) Establish WI clusters, beginning with /s/-clusters.
(b) To strengthen the specification of C1 position by: (1) eliminating the assimilations and dissimulations occurring in CVC word shapes among the stops, and (2) establishing the feature [+continuant] in WI position for coronals.

Method: (a) Moraic: Targets - (a) Anti-place assimilation/dissimilation: CVC: C1 = dorsal, C2 = Coronal. (b) Specification of [+continuant] in WI position for coronal obstruents - /#sVV(C)/ words with long vowels or diphthongs and optional WF consonants. (c) WI /sp/, /sw/.

Method: (b) Onset - Rhyme: Targets - (a) Anti-place assimilation/dissimulation: CVC: C1 = Coronal, C2 = Dorsal. (b) Specification of (+continuant) in WI position for coronal obstruents: /#s-VC? words with lax vowels in obligatory final consonants. (c) WI /st, /sn/.

(2) SEGMENTAL: - as block 1.
Block 3:
(1) Generalize /s/ and /l/ clusters through training.

SUBJECT 4:
Block 1:

(1) PROSODIC:
(a) Mapping of CVC segments. Both consonants = /k/, /t/, or /m/.
Method: Onset - Rhyme.
(b) Establish CVCV segments. Second consonant = /n/, /p/.
Method: Mora

(2) SEGMENTAL:
(a) Establish new segment /l/ features.
Method: Use oral-motor and imitation techniques.
(b) Link feature [+continuant] with coronal place to give sibilants.
Method: Use awareness and contrast techniques. Segments /s/, /ʤ/, /θ/ in WI position of CV, CVC words with final /m/.

Block 2:
(1) PROSODIC:
(a) Establish CVC
Method: Onset-Rhyme: Same word lists as Block 1 but more focus on final /f/.
(b) - Mapping
Method:- Mora: Same word list as Block 1, with concentration on /t,d/ and /p/ words.

Block 3:
(1) Generalize /l/ and sibilants into conversation.
(2) Final /s/ - Mora method. SIWW /s/ and WI /s/.

SUBJECT 5:

Block 1:
(1) PROSODIC:
(a) -Establish (C)VC
Method:- Onset-Rime: (C)VC - consonants /m/, /k/, /t/.
(b) -Mapping - SIWW consonants /n/, /p/ using lax vowels and nasal, stop, and /h/ as initial consonant.
Method: Mora

(2) SEGMENTAL:
(a) - Link [+continuant] to labial and coronal.
Method: Oral-Motor
(b)- Establish - glides /w/ and /j/ in WI position. [+sonorant] in Onset contrasting with nasals.
Method: Awareness techniques.

Block 2:
(1) PROSODIC: - same goals as block 1.
(2) SEGMENTAL:
(a) segments for CVC goal changed. New final consonant /s/.

Block 3:
(1) CVC: Final consonants - /s/, /f/, /p/, /t/, /m/, using lax vowels.
(2) CVCV: C2 consonants - /n/, /k/, /p/, /v/, /z/.
(3) Attempt to generalize best words produced into short sentences.

SUBJECT 6:

Block 1:
(1) PROSODIC:
(a) Establish CVC. Both consonants = /k/, /t/, and /m/.
Method: Onset - Rhyme
(b) Mapping CVCV. Consonants = /m/, /p/.
METHOD: mora

(2) SEGMENTAL:
(a) - Linking [+continuant] to Place and [+voice].
Method: Awareness techniques.
(b)- Establish liquids.
Method: Oral-Motor techniques

Block 2:
(1) PROSODIC:
(a) Establish syllable closure VC.
Method: Oral-Motor

(2) SEGMENTAL:
(a) -Drawing links among fricatives and affricates.
Method: Awareness techniques.
(b) Establish Liquids - work on spontaneous use in conversation.
Method: Onset-Rhyme.
(3) Work up to conversational activities.

Block 3:
(1) PROSODIC:
(a) CVC: /k/, /s/, /t/, /f/, /m/.
Method: Mora training with emphasis and rhythm on last consonant. Lax vowels. Words in rhyming groups.
(b) CVCV.
Method: Onset-Rhyme methods: Targets - /n/, /z/, /l/, Diphthongs and long vowels.

(2) SEGMENTAL:
(a) Use of fricatives.

SUBJECT 7:

Block 1:
(1) PROSODIC:
(a) To decrease the use of final /s/, /p/ adjunction, and expand the range of consonants realized in final position CVC.
(b) To strengthen the disyllabic word shape. Expansion of the range of permissible consonants in C2 position of CVCV word shapes.
Method: (a) Onset-Rime: Targets - SIWW /t,d/ and WF /m/.
Method: (b) Moraic: Targets - SIWW /m/, SIWW /n/ after lax vowels, and WF /n/ after lax vowels.

(2) SEGMENTAL:
(a) Linking root to place features for /f/ - Root node specification of [+consonantal] and [+continuant] in WI position; Place node specification of Labial Place in WI and WF positions.
(b) Target/l/ - Root node [+consonantal] in conjunction with [+sonorant] (WI and SIWW).

Block 2:
(1) PROSODIC:
(a) Targets - (a) Diphthongs /al/ and /ol/ in CVV and CVVC contexts. (b) CVCVC - WF C = /t/, /ɪŋ/.
Method: Onset-Rhyme
(b) Targets - (a) Diphthongs /au/, /ɛi/ in CVV and CVVC contexts. (b) CVCVC - WF C - /z/.
Method: Mora

(2) SEGMENTAL: - as in block 1.
Block 3:
(1) Diphthongs targeted in closed syllables and multisyllabic words.
(2) CVCVC word shape: Targets - WI clusters with /l/ and /s/.
(3) Question words and other words with WI /h/.

SUBJECT 8:

Block 1:
(1) PROSODIC:
(a) Establish CVC. Second consonant = ?k/, /n/, and /p/.
Method:- Mora.
(b) Review CVCV. Second consonant = /m/ and flap.
(2) SEGMENTAL:

(a) - Link: WI /l/ or /r/.
Method: Oral-Motor
(b) Target [+continuant] [+voice]. Link /z/, /v/, and / /.
Method: Awareness techniques

Block 2:
(1) PROSODIC:
(a) Establish CVC. Same segments.
Method:- Mora.
(b) Review CVCV -Add VCV, fricative /v/ as C2 and CVCVC (where C=ng).
(2) SEGMENTAL:
(a) - Link: review WI /l/ with move to less structured activities. Stimulate /r/.
Method: Oral-Motor
(b) Target specified coronal fricatives - [+distributed]: /θ/ and /ʒ/. branching [continuant]: /ʧ/ and /ʤ/.
Method: Awareness techniques

Block 3:
(1) PROSODIC:
(a) CVC: with focus on sentence level use. Include stops, nasal /n/ and fricative /s/, /f/.
Method: Use mora approach for single-word level.
(b) CVCV: focus on /k, /g/, /n/ .
Method: Onset-Rhyme method.

(2) SEGMENTAL:
(a) WI, SIWW /l/, (/r/).

SUBJECT 9:

Block 1:
(1) PROSODIC:
(a) Mapping CVCV: C1 = /m/, /n/, /p/, /b/, /t/, /d/, /h/, /w/, /k/, /g/, /y/. Lax vowels. C2 = /n/, /d/, /t/.
Method: Mora
(b) Establish CVC: C1 = as above. Long vowels or diphthongs. C2 = /p/, /k/.
Method: Onset-Rhyme

Block 2:

(1) PROSODIC:

(a) Mapping of /s/ to new word positions but not including word-final clusters.

Method: Mora

(b) Establish: CVCC word shape as extension of and reinforcement of CVC.

Method: Onset-Rhyme. Segments - nasal + stop, stop + /s/.

(c) Establish CVCC reviewing CVC.

Method: Onset-Rhyme.

(2) SEGMENTAL:

(a) - Linking Liquids ([+ consonantal][sonorant]) with focus on /r/ and less on /l/ as contrasting with glide /w/.

Method: Awareness techniques

(b) Review /v/. Establish [-anterior] with alveopalatal fricative and affricate.

Method: Oral-Motor

(3) More word shapes: CVC, CCVC, CV, CCV, CVCV.

(4) More available final consonants in target words: /p/, /b/, /t/, /d/, /k/, /g/.

Block 3:

(1) PROSODIC:

(a) /l/ and /r/ clusters

(2) SEGMENTAL:

(b) /θ/, /ʒ/, /r/, /tS/.

APPENDIX B

NONLINEAR PHONOLOGICAL INTERVENTION: Components and Theories

Components of therapy:

(a) Awareness or Focussed Stimulation:
- Children are made aware of their new target sound.

(b) Perceptual Contrast Training/Minimal Pair Contrasting:
- Children learn to identify/distinguish the "old" way of producing a phone or wordshape with the "new" way.

(c) Production Training:
-(i) Constituent Level choice: Depending on the child's level, phonetic training can be made at the level of isolation, syllable, word, or sentence through elicited imitation. Children move through these levels during therapy.
-(ii) Prosodic Structure Training: New word shapes are established through elicited imitation and prosodic manipulation such as prolongation, unusual stressing, syllabic constituent choice, manipulations of onsets, use of rhymes, and moraic rhythmic emphasis.
-(iii) Phonetic Training for new segments: Imitation with and without physical manipulation of the child was encouraged and oral-motor facilitation techniques used.

Mora Theory:

In the theory of the syllable and word which uses mora as basis, the principle units of the syllable are the moras, the elements that attract word stress because of their "weight." Such units are typically vowels, but may also be consonants in some languages such as English (following lax vowels). All other parts of the syllable are added on to the mora as various kinds of edges. Therapy which capitalizes on this theory focuses on the moras as beats, and the other consonants as 'add-ons' to the edges. The closest consonant before the vowel is considered to be attached to the vowel. For example, the word "snow" is made up of "s" plus "no." When you add a "snake" to the word "no" you get "snow." In a word like "cup," both the short vowel and the "p" have weight, and hence both are accentuated for imitation: "cu-p" (2 beats).

Onset-rhyme theory:

In the onset-rhyme theory of the syllable, the onset is the consonantal material before the vowel, and the rhyme is all material from the vowel to the right edge of the syllable. Although the rhyme is important because stress is attracted to complex rhymes, the onset has equal status as a syllable unit, with its own operations and constraints. Therapy which capitalizes on this theory manipulates onsets and rhymes as units. For example, in a word "snow," the "sn" is a unit: Hence the two consonants stick together and "look" for vowels to which they can attach. For a child who says "ice" but not "sigh", the rhyme "ice" can be alternated until the /s/ becomes the onset (e.g. ice ice ice ice sigh).
See Bernhardt (1994b)