Effects of Grammar Facilitation on the Phonological Performance of Children With Speech and Language Impairments

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Although there is a great deal of evidence for a significant developmental relationship between grammar and phonology, the nature of this relationship and its implications for the intervention of children with impairments in both grammar and phonology are unclear. The purpose of this investigation was to determine whether two approaches to grammar facilitation that placed no emphasis on phonology would have indirect effects on the phonological output of preschoolers with speech and language impairments. All 26 subjects, ages 44–70 months, had impairments both in grammar and in phonology. Ten subjects took part in a clinician-administered intervention program, eight subjects received a similar intervention program implemented by their parents, and eight children served as delayed intervention controls (Fey, Cleave, Long, & Hughes, 1993). The results indicated that despite a strong effect for the intervention on the children's grammatical output, there were no indirect effects on the subjects' phonological production. It is concluded that despite a close relationship between the development of grammar and phonology, language intervention approaches for children approximately 4 to 6 years of age should address phonological problems directly if significant effects on phonology are to be expected.

KEY WORDS: language disorders in children, language intervention, phonological disorders in children, phonological intervention, grammar facilitation

An impressive number of investigations over the last half century have made it clear that the developmental relationship between phonology and grammar is at least moderate in strength and that this relationship has special significance for the assessment and, possibly, intervention of children with speech and language impairments (see Aram & Kamhi, 1982; Panagos, 1982; Winitz, 1969, for reviews). For example, there is a strong tendency for disorders of phonology and grammar to co-occur. Recent estimates of the percentage of children with phonological impairments who also have delays in grammatical development cluster around 80% (e.g., Paul & Shriberg, 1982—86%; Shriberg & Kwiatkowski, 1988—75%; Shriberg, Kwiatkowski, Best, Hengst, & Terselic-Weber, 1986—76%). Children with specific language impairments originally identified as having problems in grammar also have been found to have significant deficits in phonology (Bishop and Edmundson, 1987—79%, computed from Table 7, p. 168).

When a child with both speech and language learning problems is identified, the speech-language pathologist must ask whether intervention should be focused primarily or exclusively on speech or language or whether all linguistic domains can and should be addressed simultaneously from the outset. The answer to this question will depend, in large part, on the nature of the relationship between developmental disorders of phonology and other linguistic components, both in general and for the
specific child in question. If the child’s speech and language impairments are, in many respects, coincidental rather than interdependent, it may be necessary to address all components directly. On the other hand, if the association reflects an underlying dependency between phonological learning and learning in other linguistic domains, intervention that emphasizes certain areas (e.g., semantics, grammar) might effect spontaneous improvements in other areas (e.g., phonology). Hoffman, Norris, and Monjure (1990) describe the relationship between different components of language as synergistic, and they use this notion of synergy to explain the across-domain pattern of results they observed with the story-based “whole language” intervention approach they tested. “The general principle underlying these results may be that language tasks requiring the organization of higher levels of language simultaneously affect refinements in lower levels” (p. 108). From a clinician’s standpoint, a strategy of addressing higher level language functions with no direct emphasis on phonology may be highly efficient and easy to administer. The major question for clinicians and for the current investigation is whether or not this strategy consistently results in spontaneous gains in phonological production.

Given the potential contribution of intervention efficacy studies to theory and clinical practice, it is surprising that so few investigations have sought to assess the indirect effects of language intervention on speech sound production. In the studies reported to date, the results are mixed.

Matheny and Panagos (1978) presented the first published account of an intervention methodology to test the hypothesis that intervention focused on grammar could have a significant influence on children’s phonologies. These investigators used the tightly structured and highly imitation-based Monterey approach to language intervention (Gray & Ryan, 1973) with a group of 5- and 6-year-old children with speech and language impairments. Following 5 months of this intervention, Matheny and Panagos’ (1978) subjects exhibited gains in both syntax and articulation that were significantly greater than the changes made by a no-intervention control group. As intimated by Gray and Ryan (1973, p. 49), it may be that requiring children to imitate syntactic forms leads them to make spontaneous attempts to match the articulatory characteristics of the models as well. If this is the case, the mechanism for articulation change in the Matheny and Panagos study may have been relatively simple and direct: The children’s speech improved because imitative practice of new sentence stimuli also provided matching-to-stimulus practice in and reinforcement for more accurate speech sound production. This type of influence is interesting and important, but qualitatively different from the synergistic influences postulated by Hoffman et al. (1990).

The drill employed by Matheny and Panagos (1978) was not available in the much less structured and more child-oriented approach evaluated by Hoffman et al. (1990), however. One of the two preschool brothers with speech and language impairments in this study received no direct speech intervention. Instead, he participated in story-retelling activities that stressed the inclusion of propositional information into narrative descriptions. Following the 6-week intervention, this subject exhibited significant gains in a number of semantic and syntactic features. He also made gains in phonology that were commensurate with those of his brother (the second member of a triplet cohort), who received only phonological intervention targeting cluster reduction. Although this second subject made some gains in the production of complete sentences following phonological intervention, overall improvements in semantic and syntactic features of story-telling appeared not to be as great as for the child who received only language intervention. The results of this investigation suggest that intensive clinician-directed speech/language drill is not necessary to ensure an indirect effect of language intervention on preschoolers’ phonological output.

This conclusion was not supported by the findings of Tyler and Watterson (1991), however. These investigators evaluated a language intervention designed to facilitate grammatical forms that included a story-retelling intervention procedure similar to but more structured than that of Hoffman et al. (1990). Contrary to the results and conclusions of Hoffman et al., these investigators claimed that “Language intervention for subjects in this study with a severe overall language and phonological disorder generally resulted in positive change in language with associated negative change in phonological skills” (p. 155). In other words, the language intervention provided in this study appeared to Tyler and Watterson to have resulted in a trend toward regression rather than improvement in phonological performance.

There are a number of factors that may have contributed to the inconsistency of results in the intervention studies cited above. For example, in both of the studies that report an influence of language intervention on phonology (Hoffman et al., 1990; Matheny & Panagos, 1978), the subjects appear to have been only mildly impaired in both phonology and grammar. In contrast, the subjects of Tyler and Watterson (1991), who had more severe phonological and grammatical impairments, did not make improvements in phonology following language intervention. It is important to note, however, that Tyler and Watterson found no effects for either phonological or grammatical performance after the 9-week language intervention period. With no clear effect of intervention in the targeted linguistic domain (i.e., grammar), there is little reason to expect consistent gains in the nontargeted area (i.e., phonology). In sum, the differences in subjects, in interventions, and in the responses of subjects to intervention make it impossible to come to any firm conclusions regarding the effects of language intervention on the phonological output of children with speech language impairments.

The purpose of the present investigation was to enhance our understanding of the phonology/grammar relationship by evaluating the indirect effects of two similar approaches to grammar facilitation on the phonological production of preschoolers with language impairments (LI) (Fey, Cleave, Long, & Hughes, 1993). The subjects for this study originally were identified on the basis of the presence of a significant deficit in grammatical expression. Intervention was provided directly by a speech-language pathologist or by the child’s own parents, who were trained in the use of intervention procedures by the speech-language pathologist. Each intervention focused squarely on the children’s deficits in grammar rather than their problems in phonology. The primary
intervention strategy involved the use of focused stimulation procedures (Camarata & Nelson, 1991; Fey, 1986; Fey et al., 1993), in which no requests were made for the subjects to imitate or otherwise produce responses. The subjects were exposed to very little drill of any kind, and no direct instruction on the production of speech sounds was provided in either intervention. Thus, if gains in phonology resulted from the intervention, it could not be argued that they were the result of a serendipitous increase in drill of speech sounds or sound patterns, as may have been the case for the study of Matheny and Panagos (1979).

Fey et al. (1993) presented evidence that their interventions had strong positive effects on their subjects' grammatical production. Our a priori hypothesis for the present study was that these gains in expressive grammar would be accompanied or followed by spontaneous improvements in phonological production. There are at least two specific mechanisms that could be responsible for such an indirect effect resulting from the successful grammar facilitation observed in our earlier study. These mechanisms are described in the next section.

Mechanisms for Indirect Effects of Grammar Development on Speech Production

The first potential mechanism is related to the fact that both grammatical and phonological production require significant cognitive resources. If the resource demands of grammar production could be reduced (e.g., through language intervention), more resources would be available for phonological processing.

There is a large and growing literature implicating grammatical complexity in many of the phonological simplifications of children with language impairments. For example, Menyuk and Looney (1972) demonstrated that even when sentence length is constant, children with language impairments make more speech sound errors in their imitations of complex sentences than in imitations of simple sentences. This effect on imitated sentences has been replicated and extended by Panagos and his colleagues (Panagos & Prelock, 1982, 1984; Panagos, Quine, & Klich, 1979; Schmauch, Panagos, & Klich, 1978) and by Masterson & Kamhi (1992). Furthermore, it is well established that the phonological simplifications found in connected speech are different from and often more frequent than those found in isolated word productions (Andrews & Fey, 1986; Dubois & Bernthal, 1978; Johnson, Winney, & Pederson, 1980; Klein, 1984; Morrison & Shriberg, 1992).

The combined influences of grammatical and phonologic complexity cannot account for all patterns of phonological simplification in spontaneous speech (Masterson & Kamhi, 1992; Paul & Shriberg, 1982, 1984). Still, it is clear that production of new, less familiar, more grammatically (and phonologically) complex utterances places a burden on children's sentence production processes and that such utterances often are characterized by phonological simplifications. As the child gains facility in the production of new and emerging forms at the levels of morphology and syntax, this processing burden may be reduced, leading to an indirect reduction in phonological simplifications. Thus, if grammar facilitation can speed the processes of development of new forms, improvements in speech sound production could result.

It is important to note that the changes expected from this type of mechanism primarily would be improvements in the production of sounds already present in the child's repertoire. That is, with processing resources freed up, sounds that sometimes are produced correctly would be expected to be produced correctly with even greater consistency.

The second mechanism that might lead to a prediction of improvements in phonology following a successful program of grammatically based intervention depends less on the interdependence between the two linguistic domains than on the similar types of learning necessary to achieve mastery in either domain. For example, to make a change in grammar or phonology, the child must recognize that the output generated by her or his existing system differs from that of the ambient environment. The child then must seek out the relevant characteristics of such differences and develop (or select from an innate set of options) a hypothesis that best accounts for the data observed (Menn, 1983; Nelson, 1989). It may be that some children's language learning difficulties lie in (a) recognizing the differences between their own output and that of the language of competent individuals in their environment (e.g., a new or different sound in a familiar word or a new grammatical morpheme) and/or (b) formation of or incorporating into their own grammars the new forms or the new categories or rules underlying these forms (e.g., a new phonemic opposition or new functional categories, such as determiners or auxiliary verbs [Leonard, 1989; Leonard, Sabbadini, Volterra, & Leonard, 1988]). Intervention such as that employed in our grammar facilitation approaches is designed to lead the child to relevant language features and to foster the hypothesizing of concepts, categories, and rules of grammar. Such interventions also might be expected to encourage the child to seek evidence for new concepts, categories, and rules in other language domains, including phonology.

This second mechanism for phonological change could lead to changes in the consistency of sound productions, as was the case for the first mechanism. It also might stimulate a child's search for entirely new sound patterns. Thus, successful intervention that leads the child to new grammatical realizations could result in productions of sounds not present in the child's existing phonology.

Experimental Questions and Predictions

The current investigation directly addressed three questions:
1. Do successful efforts to facilitate grammar lead to gains in phonological development?
2. Are gains in grammar (as measured by Developmental Sentence Score [DSS] [Lee, 1974]) correlated with gains in phonology (as measured by percentage consonants correct?)
3. Are indirect gains in phonology greater in response to a clinician-administered intervention than a similar intervention approach applied by the subjects’ parents?

Despite the rather limited evidence from intervention studies preceding this investigation, we predicted that the first two of these questions would be answered “yes.” As for the third question, it may seem unlikely that there would be differences in the effects of our two intervention models because they were so similar. However, the clinician-administered intervention (discussed in the next section) involved a brief period of imitative drill on the subjects’ grammatical targets each week. On the basis of the indirect effects on phonology of the imitation-based grammar intervention of Matheny and Panagos (1978), it was reasoned that this drill could pose some small advantage for the clinician group.

Method

Subjects

The subject pool. Subjects were selected from the pool of 30 children who participated in the language intervention study of Fey et al. (1993). At the beginning of this investigation, the 30 subjects ranged in age from 44 to 70 months (M = 55.57; SD = 6.34), had performance IQs between 72 and 130 (Leiter International Performance Scale [Leiter, 1979]) (M = 96.7; SD = 16.29), and had Developmental Sentence Scores (DSSs) that placed them at or below the 10th percentile for either chronological or mental age, whichever was lower (M = 4.32; SD = 1.30). Although not all subjects met the intelligence criterion typically accepted for specific language impairment (i.e., IQ > 85), they all had Leiter performance IQs above 72 and had significant discrepancies between their performance on the Leiter and their grammatical production, as measured by DSS. The speech of many of these subjects was difficult to understand, and all were generally intelligible with the contextual support found on our videorecordings. One child who met all other criteria was excluded from the principal study because we believed that he would profit most from an approach that focused primarily on phonology. This child was highly unintelligible, but his sentence (and sentence-like) productions were so complex that we concluded that his delays in grammar were the consequence of his limited phonological skills. This judgment was admittedly based on a clinical hunch, but it is noteworthy that we had the impression of a general causal influence of phonology on grammatical output for only this child.

Subject identification and intervention delivery plan.

Table 1 presents an overview of the intervention delivery plan for the study. The first wave of subjects was identified at the outset of the investigation. At this time, 20 subjects were assigned at random to receive one of the two grammar facilitation interventions. Six subjects were selected to receive the clinician intervention immediately, and 5 were chosen to participate immediately in the parent intervention. These subjects (hereafter referred to as the first intervention subgroups) then received 10 months of intervention. Nine additional children were assigned from the outset to a delayed intervention control group (referred to as the second intervention subgroups). After waiting 5 months without intervention, 4 of these subjects took part in the clinician intervention and four received the parent intervention.

Following completion of the 10-month intervention programs for the first two intervention subgroups, a second wave of 10 subjects (i.e., the third intervention subgroup) was identified. Five subjects were assigned at random to either the clinician or parent intervention group. These subjects received only 5 months of intervention. In all, 30 subjects participated in the original study. Of these subjects, 15 received at least 5 months of language intervention from the clinician, and 14 received at least 5 months of intervention directly from their parents.

Exclusionary criteria. To evaluate the subjects’ phonologies, the Assessment of Phonological Processes-Revised (APP-R) (Hodson, 1986) was administered to each subject at each test period. The presence and severity of a phonological disorder was determined by entering transcriptions into Computerized Analysis of Phonological Processes (CAPP) (Hodson, 1985). This program yields a phonological deviancy score to which a severity descriptor is attached. Of the 30 subjects who began the study, 27 (90%) had phonological deviancy scores on the APP-R associated with phonological impairments in the moderate to profound range. Nineteen of these 27 subjects (70%) had moderate impairments, 6 (22%) had severe impairments, and 2 (7%) fell into the profound category.

To evaluate the indirect effects of grammar facilitation on phonological development, it was important to ensure that all subjects had sufficient room for growth on measures of phonology. Therefore, to avoid possible ceiling effects in
**TABLE 2. Pre-experimental statistics on nonspeech variables for the subjects in each experimental group.**

<table>
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<th>Sub</th>
<th>Sex</th>
<th>Age (in months)</th>
<th>TACL-R*</th>
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<th>IQc</th>
<th>DSSd</th>
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**Clinician Treatment Group**

- M 54.75 -0.39 93.50 96.00 4.28 2.89
- SD 6.04 1.15 12.90 20.25 1.42 0.73

**Parent Treatment Group**

- 1 M 53 -1.75 79 126 3.56 3.12
- 2 F 55 -1.56 78 72 2.57 2.05
- 7 M 55 -0.39 94 87 4.34 2.89
- 21 F 58 -1.04 82 97 5.91 3.38
- 31 M 44 0.77 93 103 3.86 3.08

**Delayed Treatment Group**

- 3 F 67 -2.33 54 82 5.65 3.82
- 13 M 58 -0.28 105 119 5.61 3.26
- 14 M 57 -0.05 82 91 2.90 2.73
- 16 M 56 -1.48 99 76 5.37 2.68
- 17 M 60 -2.33 72 85 3.59 2.38
- 18 M 45 0.61 117 92 2.97 2.60
- 20 M 52 -1.13 84 103 3.19 2.22
- 23 M 50 -1.08 95 109 5.49 3.35

**M 55.63 -1.01 88.50 94.63 4.35 2.88
- SD 6.70 1.06 19.86 14.59 1.28 0.54**


Data on pre-experimental nonspeech variables for the three experimental groups are presented in Table 2. None of the differences in means shown in the table approached statistical significance, Fs (2, 23) < 1.0; ps > .50. Table 3 contains pre-experimental measures of phonology, including the phonological deviancy score (PDS) (Hodson, 1986), the percentage consonants correct (PCC) (Shriberg & Kwiatkowski, 1982), and the percentage use of four phonological processes often implicated in problems of grammatical morphology in children with speech and language learning problems. These include final consonant deletion (FCD), word-final cluster reduction (FCR), stopping of early developmental delayed treatment control group (the control group, n = 8).

In a study by Garrett and Moran (1992), PCC was calculated using Version 6.0 of the PROPH+ module of Computerized Profiling (Long & Fey, 1988). As noted by these investigators, when calculating PCC, this version of PROPH+ treated consonant clusters differently than originally described by Shriberg and Kwiatkowski (1982). Therefore, this PCC could differ markedly from that computed in the manner of Shriberg and Kwiatkowski. In the present investigation, PCC was calculated using a new version of Computerized Profiling (Long & Fey, 1993). In this version of the program, each segment of a consonant cluster is counted as an opportunity for a correct consonant production, as suggested by Shriberg and Kwiatkowski. Thus, although the measure reported in this investigation is consistent with the calculations recommended by Shriberg and Kwiatkowski, it is somewhat different from that reported by Garrett and Moran.
TABLE 3. Pre-experimental statistics on phonological variables for the subjects in each experimental group.

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<td>25</td>
<td>16</td>
<td>37</td>
<td>27</td>
</tr>
<tr>
<td>13</td>
<td>33</td>
<td>66.7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>70</td>
</tr>
<tr>
<td>14</td>
<td>34</td>
<td>66.7</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>16</td>
<td>39</td>
</tr>
<tr>
<td>16</td>
<td>21</td>
<td>82.6</td>
<td>3</td>
<td>0</td>
<td>7</td>
<td>0</td>
<td>22</td>
</tr>
<tr>
<td>17</td>
<td>66</td>
<td>38.1</td>
<td>46</td>
<td>40</td>
<td>0</td>
<td>25</td>
<td>88</td>
</tr>
<tr>
<td>18</td>
<td>55</td>
<td>41.6</td>
<td>11</td>
<td>100</td>
<td>28</td>
<td>43</td>
<td>91</td>
</tr>
<tr>
<td>20</td>
<td>24</td>
<td>73.9</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>23</td>
<td>44</td>
<td>49.6</td>
<td>0</td>
<td>40</td>
<td>30</td>
<td>26</td>
<td>68</td>
</tr>
<tr>
<td>M</td>
<td>39.50</td>
<td>59.83</td>
<td>9.50</td>
<td>31.75</td>
<td>10.13</td>
<td>19.00</td>
<td>52.63</td>
</tr>
<tr>
<td>SD</td>
<td>15.20</td>
<td>15.68</td>
<td>15.40</td>
<td>31.86</td>
<td>12.92</td>
<td>16.53</td>
<td>30.19</td>
</tr>
</tbody>
</table>

Note. All measures are based on analyses of productions from the APP-R (Hodson, 1986).


Procedures

The particulars of the intervention procedures, language sampling contexts, transcription of language samples, reliability of the language sample transcripts, and calculation of DSS are provided in Fey et al. (1993). Some information on the interventions is necessary, however, to understand the nature of the particular grammar-to-phonology influence we were exploring. Additionally, information on the collection and transcription reliability of the speech samples, which has not been reported previously, is provided.

The intervention programs. Subjects assigned to the clinician intervention took part in three 1-hour intervention sessions weekly. One of these sessions was individual, and the other two involved groups of up to six language-impaired children. All sessions were administered by the project speech-language pathologist (PLC).

Because all subjects reduced word-initial clusters to some extent, percentage use of initial cluster reduction for each subject also is provided in Table 3. Although there was considerable variability among subjects both within and across groups on these measures, especially on the processes, careful examination of this table shows that the groups were well matched on these pre-experimental measures of phonology. Again, none of the mean differences were statistically significant, $F(2, 23) < 1.0; ps > .50.$
Subjects who participated in the parent intervention received no direct intervention from PLC. Instead, parents were trained in the use of intervention procedures by PLC in 12 weekly sessions attended only by the parents. These sessions averaged approximately 2 hours in length. Following the 12-week training period, parent group meetings took place on a monthly basis. Over the entire course of the program, parents also brought their children for an individual session with PLC on a once per month basis. Thus, after the initial 12-week intervention, parents took part in one monthly individual and one monthly group session designed to provide emotional support, to help parents hone skills, to address any questions that arose regarding intervention procedures, and to make modifications in children's intervention goals. Although the parent intervention was intensive by the standards of many parent programs, it took only approximately 53% of the time per child required to administer the clinician intervention (Fey et al., 1993).

**Intervention protocols.** Four specific goals of language form were selected for each child in each intervention group. These goals were attacked in cyclical fashion. One goal was emphasized each week. In each successive week, the next goal was targeted regardless of the effects of intervention on the previous goal. After all four goals were treated, a new cycle began, starting with the first goal. As children began to use a target form productively, goal modifications were made. For example, related goals (e.g., auxiliaries am and will) might have been combined so that multiple goals were targeted during the same week. Alternatively, the newly acquired or mastered form might be dropped from the intervention regimen altogether. In either case, room was left for the addition of new specific objectives. The specific goals for one subject over eight cycles are shown in Table 4. This subject had a characteristic profile involving primarily simple sentences and frequent omission of auxiliary verbs and other grammatical morphemes. Many errors involved sentence subject-related properties, such as use of accusative case pronouns in subject position (e.g., him/he, them/they) and failure to mark the third person singular morpheme on verbs (e.g., "sees", "stays").

The primary intervention procedures in both interventions fall under the general rubric of focused stimulation techniques (Fey, 1986; Fey et al., 1993). This includes frequent modeling of target forms and the use of sentence recasts containing target forms in response to child productions (e.g., Nelson, 1977, 1989). Focused stimulation was provided in highly naturalistic tasks. For example, parents who took part in the parent intervention were encouraged to use the techniques as they read to their children, bathed them, played with them, and so on. In the clinician intervention, children engaged in making sandwiches, popping corn, planting beans, and other activities appropriate for preschoolers.

In general, subjects were not required to produce target forms, and the only reinforcers that were provided following target productions were pragmatically appropriate verbal and/or nonverbal consequences to the children's communicative intentions. The one instance where children were required to respond was in the clinician intervention. At the beginning of each weekly individual session, subjects were engaged in approximately 10 min of imitative drill. During this activity, subjects were required to imitate the target form (e.g., the modal, will) and a contrast target (e.g., the regular past tense inflection, -ed) as the clinician acted out simple stories using pictures, dolls, and other props. Subjects were not required to produce their target forms at any other time as part of either intervention protocol.

**Dependent measures.** Measures of expressive grammar and phonology were taken pre-experimentally and at approximately 5-month intervals thereafter. Thus, subjects in the first intervention subgroups were tested three times (at 0, 5, and 10 months post-onset), subjects from the second intervention subgroups were tested four times (0, 5, 10, and 15 months post-onset), and subjects from the third intervention subgroups were evaluated twice (0 and 5 months post-onset).

Despite its many weaknesses, DSS (Lee, 1974) was selected as the primary measure of the subjects' expressive grammatical abilities. DSS has been shown to be sensitive to the types of grammatical deficiencies found in the expressive language profiles of children with language impairments. The measure also has proven sensitive to changes in children's grammatical output resulting from grammar facilitation programs (see Hughes, Foy, & Long, 1992, for a review).

At each testing period, 30-min language samples were collected from interactions between the subjects and their primary caregivers, usually their mothers. All sentences from these samples that contained a noun and a verb in subject-

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**TABLE 4. Specific goal sequence for S5, a 47-month-old girl, over a 9 1/2-month intervention period.**

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Specific Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Focus on will to express predictions and future modality.</td>
</tr>
<tr>
<td>2</td>
<td>Focus on are as an auxiliary and copula to mark tense and number (in contrast with is).</td>
</tr>
<tr>
<td>3</td>
<td>Focus on is as an auxiliary and copula to mark tense and number (in contrast with are).</td>
</tr>
<tr>
<td>4</td>
<td>Focus on infinitive complements requiring the particle, to.</td>
</tr>
<tr>
<td></td>
<td>Focus on a variety of different matrix verbs (e.g., try to help, like to eat).</td>
</tr>
<tr>
<td>7</td>
<td>1. Discontinue focus on will, is, and are.</td>
</tr>
<tr>
<td></td>
<td>2. Discontinue work on infinitive complements.</td>
</tr>
<tr>
<td></td>
<td>3. Add isn't as auxiliary and copula to contrast with don't and won't.</td>
</tr>
<tr>
<td></td>
<td>4. Add he and she as nominative case pronouns in subject position to contrast with accusative case him and her.</td>
</tr>
<tr>
<td></td>
<td>5. Add but and or as coordinating conjunctions to express antithesis and optionality.</td>
</tr>
<tr>
<td>8</td>
<td>1. Focus on will, is, and are in wh-questions.</td>
</tr>
<tr>
<td></td>
<td>2. Discontinue work on don't, won't, and isn't.</td>
</tr>
<tr>
<td></td>
<td>3. Add they contrasted with them to he and she.</td>
</tr>
<tr>
<td></td>
<td>4. Add third-person, singular, present tense -s (e.g., &quot;He plays&quot;).</td>
</tr>
</tbody>
</table>

Note. Treatment was interrupted for 2 weeks in the middle of the treatment period for testing.
predicate relationship were scored using DSS (Lee, 1974). Although DSS calls for only 50 subject-verb sentences, each experimental group averaged over 95 utterances in this study. DSS has been shown to be more reliable with samples of increasing length (Johnson & Tomblin, 1975). Methods for assessing transcription and DSS coding reliability are described in detail in Fey et al. (1993).

Each child's responses to APP-R stimuli were transcribed by one of the investigators (AIR or MEF). After all testing was completed, another judge transcribed 30 of the 70 APP-R tapes (43%). Segmental transcriptions were viewed as agreements when they were identical in manner, place, and nasality features. Transcriptions that differed only in voicing were coded as agreements. Interjudge reliability scores averaged 94% (range = 72–99%).

The APP-R data were entered into the PROPH+ module from Computerized Profiling (Long & Fey, 1993). Along with a large amount of descriptive information, this program yields a percentage consonants correct (PCC) score. This score is calculated in the same manner as that developed by Shriberg and Kwiatkowski (1982). Our use of this score differs from the Shriberg and Kwiatkowski procedure, however, in that it is based on responses to isolated words rather than on connected speech samples.

Results

Because four subjects from our original study (Fey et al., 1993) were excluded from the present investigation, it was necessary to verify that the grammar facilitation still showed a positive effect for the remaining subjects. A one-way analysis of covariance (ANCOVA) was performed with the subjects' pre-experimental DSS as the covariate and DSS at 5 months post-experimental onset as the dependent measure. This test yielded a highly significant intervention effect, $F(2, 23) = 10.60; p = .0006$. This effect is illustrated in Figure 1. Planned comparisons demonstrated that the gains for both intervention groups were greater than those for the control group, $F(1, 22) > 13; ps < .002$, but that the difference in gains between intervention groups was nonsignificant, $F(1, 22) = .74; p = .398$. The magnitude of the effects for intervention were roughly the same or greater than those observed when all 30 subjects were included in the analysis (Fey et al., 1993).

Our experimental questions 1 and 2 dealt with the indirect effects of gains in expressive grammar on the children's phonological output. To address these questions, gains in PCC for the intervention group subjects were compared with those of the control group subjects. PCC scores pre-experimentally and at 5-months post-experimental onset are illustrated in Figure 2. This figure reveals that PCC gains were very small across all three groups. A one-way ANCOVA with pre-experimental PCC as the covariate and PCC at 5 months post-onset as the dependent variable confirmed that the gains in PCC did not differ across the groups, $F(2, 22) = .68; p = .52$. Thus, despite their effectiveness in modifying the subjects' grammatical output, neither of the grammar facilitation interventions had an effect on the subjects' phonological production.

The finding of no intervention effects on PCC does not rule out the possibility that gains in PCC were related to gains in DSS. For example, although average gains in PCC were small, there was considerable variability in performance within each group. Therefore, it is still possible that subjects who made the greatest gains in DSS following intervention also improved most in speech production. Such an effect

*Because errors in voicing were excluded from estimates of transcription reliability, productions that differed from the target only in voicing were entered as if the target had been produced correctly. Thus, voicing errors are not reflected in PCC, as measured in this study.

*In a recent investigation by Garrett and Moran (1992), PCC calculated from connected speech samples was highly correlated with PCC based on single-word responses to the APP-R stimuli ($r = .83$). More importantly, PCC based on the APP-R responses was correlated as highly with judgments of severity as was PCC based on connected speech ($rs > .90$ for both methods).
could be masked in tests comparing group means. To examine this possibility, gains in DSS following 5 months of intervention were correlated with gains in PCC following 5 months of intervention within each intervention group. To increase sample size and to add statistical power to the analysis, the data for the subjects in the second intervention subgroups (i.e., the delayed intervention controls) were pooled with the data for the first and third intervention subgroups. Thus, the gains for all subjects reflected changes in DSS and PCC from the point immediately before intervention (i.e., at 5 months post-experimental onset for the delayed intervention subjects) to the testing immediately after 5 months of intervention (i.e., at 10 months post-onset for the delayed intervention subjects). The correlation between PCC gains and DSS gains was not significant with all 26 subjects included ($r = -.03, p = .89$) or for either the clinician group ($r = -.17; p = .57; N = 14$) or the parent group ($r = .11; p = .74; N = 12$). Thus, not only was there no effect for PCC resulting from intervention, there was virtually no correlation between gains in DSS and PCC for either intervention group.

Before rejecting the hypothesis that developments in grammatical expression would be accompanied by similar developments in phonology, another possibility remained to be tested. If the intervention was successful in focusing the subjects’ attention on grammatical form, it could be that they had no additional resources to commit to making changes in other areas, such as phonology. If this were the case, any spontaneous gains in phonology might be expected to lag behind changes in grammar. This hypothesis was tested by examining the performance of the subjects in all three experimental groups over a 10-month period as opposed to the 5-month period on which all results reported thus far are based. Six subjects in the clinician group, 4 in the parent group, and 8 in the control group participated in the experiment for 10 months.

The PCC data for these subjects at 0, 5, and 10 months post-experimental onset are illustrated in Figure 3. Two general points are made clear in this figure. First, average gains were always small and never greater for one group than another. The first point is especially revealing from the standpoint of the control subjects. For this group, very small gains in PCC were anticipated from 0 to 5 months, because the subjects in this group received no intervention over this period. Note, however, that the gain in PCC from 5 to 10 months is also extremely small despite the fact that the subjects received grammatical intervention over this period.

Finally, Tyler and Watterson (1991) suggested that the influence of language intervention on phonological development may be greatest for children who are relatively mildly impaired. This might account for the significant change in phonological production shown by the language intervention subject of Hoffman et al. (1990). This child had a preintervention APP-R score of 25, whereas the mean APP-R score for the 26 subjects studied in our investigation was 38.23 ($SD = 12.76, range = 21–71$). Thus, the Hoffman et al. subject fell into the mildest end of the severity distribution for our subjects. To explore the hypothesis that children with less severe phonological impairments should profit most from our intervention, we examined the profiles of all of our subjects with phonological deviancy scores less than 30. The PCCs, DSSs, and the percentage use of initial cluster reduction for these subjects are provided in Table 5. Two of the 7 subjects shown in the table do indeed exhibit larger gains in PCC than could be anticipated from the performance of the entire group.

![FIGURE 3. Mean PCC at pretest, 5 months post-onset, and 10 months post-onset for subjects who participated for at least 9 1/2 months. (*Subjects in the control group had received no intervention at 5 months post-onset and 5 months of intervention at 10 months post-onset.)*](image)

### TABLE 5. Percentage Consonants Correct (PCC), Developmental Sentence Scores (DSS), and percentage use of Initial Cluster Reduction (ICR) immediately before intervention and after 5 months of intervention for subjects with the least severe phonological impairments.

<table>
<thead>
<tr>
<th>Subjects</th>
<th>PCC-Pre</th>
<th>PCC-Post</th>
<th>DSS-Pre</th>
<th>DSS-Post</th>
<th>ICR-Pre</th>
<th>ICR-Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>80.5</td>
<td>75.7</td>
<td>4.34</td>
<td>5.13</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>8</td>
<td>72.0</td>
<td>73.4</td>
<td>3.84</td>
<td>5.21</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>12</td>
<td>71.4</td>
<td>86.4</td>
<td>4.51</td>
<td>5.98</td>
<td>37</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>88.4</td>
<td>86.7</td>
<td>4.76</td>
<td>6.26</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>19</td>
<td>72.9</td>
<td>80.4</td>
<td>4.74</td>
<td>4.73</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>20</td>
<td>69.5</td>
<td>62.7</td>
<td>2.85</td>
<td>4.02</td>
<td>33</td>
<td>4</td>
</tr>
<tr>
<td>38</td>
<td>63.2</td>
<td>79.7</td>
<td>3.86</td>
<td>5.95</td>
<td>33</td>
<td>33</td>
</tr>
</tbody>
</table>

**Note.** Severity of phonological impairment was determined using the phonological deviancy score from the APP-R (Hodson, 1986).

*Higher PCC scores reflect more accurate performance. Lower IRC scores reflect less frequent reduction of word-initial clusters.*
The large reductions in ICR observed for five subjects shown in Table 5 made us question whether our grammar facilitation led to more consistent cluster production even though no relationship between gains in DSS and ICR reduction was observed. A one-way ANCOVA with ICR at 5 months post-intervention yielded a nonsignificant coefficient \( r = .04, p = .84 \).\(^7\)

**Discussion**

In this investigation, 90% of the subjects identified as having language impairments on the basis of a discrepancy between grammatical expression (as determined by DSS) and age (i.e., the lower of chronological or mental age) also had impairments in phonology judged to be at least moderate in severity. This is even greater than that of Shriberg and colleagues who have reported that approximately 80% of phonologically impaired children exhibit deficits in grammatical production (e.g., Paul & Shriberg, 1982; Shriberg & Kwiatkowski, 1988; Shriberg, Kwiatkowski, Best, Hengst, & Terselic-Weber, 1986). It is also greater than Bishop and Edmundson’s (1987) observation that 79% of their subjects with specific language impairment who had deficits in syntax also exhibited significant impairments in phonology. It is important to point out that many of the subjects in the present investigation had Leiter IQ scores that fell below the criterion used for identification of subjects with specific language impairments studied by Bishop & Edmundson. This and differences in criteria for determination of phonological impairment may account for at least a portion of the differences noted between earlier studies and the present investigation.

Regardless of which incidence figures best reflect the actual correspondence between impairments of grammar and phonology, it is clear from this and other investigations that at least a small percentage of subjects may be deficient in one area and escape significant impairment in the other. Thus, the relationship between phonology and grammar in populations of speech and language-impaired children should be expected to be neither perfect nor simple.

A number of findings from the present investigation suggest that despite obvious surface-level dependencies between grammatical and phonological form (e.g., many English grammatical inflections cannot be produced unless word-final consonants can be produced), there is a great deal of independence between developments in grammatical and phonological production. The subjects in both the clinician and parent groups made significant gains in expressive grammar, as measured by DSS. This finding indicates that moderate to profound impairments in phonology do not preclude significant gains in grammar over a 5-month intervention period for preschoolers with language impairments.

Contrary to our hypothesis, however, the subjects who received the grammar interventions and made significant gains in grammatical expression made no greater gains in phonological performance than did the control group children, who received no intervention and exhibited negligible improvements in grammar. Furthermore, gains made in DSS were not correlated with gains made in PCC for the entire group of subjects or within either intervention group. Finally, when we examined our subjects’ APP-R performance 10 months after the onset of the experiment, we found no evidence that spontaneous phonological developments lagged behind early developments in expressive grammar.

There are three major factors that might explain the different pattern of results found in this study and earlier studies of Matheny and Panagos (1978) and Hoffman et al. (1990) regarding the effects of language intervention on phonological production. These are (a) differences in intervention approaches, (b) differences in subjects treated, and (c) differences in research methodologies.

**Differences in intervention approaches.** First, because the language intervention approaches that we used were different from those employed by Matheny and Panagos (1978) and Hoffman et al. (1990), it is possible that the mechanisms responsible for the indirect effects of these interventions on phonological performance were absent in our approaches. It seems clear that this is the case when comparing our interventions with that of Matheny and Panagos. As noted in the introduction, Matheny and Panagos used a language intervention program that was heavily dependent on imitation of and reinforcement for accurate production of language forms. Subjects may have treated untargeted speech sounds as well as targeted language goals as discriminative stimuli. Thus, the clinician-guided drill of language forms also may have influenced their speech production.

The tightly structured and highly imitative grammatical intervention of Matheny and Panagos (1978) contrasts sharply with the approaches we used in the present investigation. Imitation was not employed at any point in the parent intervention, and it played only a small role in the clinician intervention (i.e., 10 min of imitative drill out of a total of 180 min intervention weekly). Furthermore, with the exception of
the brief drill used in the clinician intervention, intervention procedures were employed during highly naturalistic tasks, such as planting seeds or making crafts (especially in the clinician intervention), getting dressed, bathing, or setting the table (especially in the parent intervention), or during play (both interventions). Intervention procedures in these contexts comprised frequent models of target forms and recasts of children's sentences that contained the target for the week. Thus, practicing of target forms took place almost exclusively during routine or preschool-type activities, where the forms were produced spontaneously and served a clear communicative function. If we had assumed that improvements in phonology following intervention for grammar were dependent upon drills that require the child to match an adult stimulus overtly, we could have predicted that our intervention approaches would be inadequate to the task.

The results of the investigation of Hoffman et al. (1990), however, suggest that elicitation of neither grammatical nor phonological forms is essential to achieve marked gains in both grammar and phonology. Although the procedures used by these investigators involved story retelling and, therefore, provided opportunities for delayed imitation, no overt attempts were ever made to elicit particular forms. Instead, the interventionist modeled for the child, recast sentences, and requested information when the communicative context made such acts useful if not necessary for the negotiation of meaning. Hypothesized gains in phonology resulting from this type of intervention must be expected via a mechanism very different from that which may have been operating in Matheny and Panagos' (1978) situation. When children are challenged to modify their messages in the interest of communication and are presented with naturally occurring models of target forms not yet acquired or mastered, they may not limit their search for new communicative options to grammatical, propositional, or discourse targets. They may also seek new patterns of pronunciation. If so, the outcomes of such an intervention might extend well beyond the domain of grammar (Hoffman et al., 1990). Indeed, our hypotheses regarding spontaneous phonological gains hinged on the assumption that this sort of mechanism would be operative in the children we treated. Unfortunately, our data provide no indication that learning of this sort took place.

There are several differences between the intervention protocol used in our investigation and the particular model of "whole language" intervention provided by Hoffman et al. (1990). Consequently, it might be argued that because of these differences a general effect such as that observed by Hoffman et al. should not have been anticipated. For example, we selected a set of specific grammatical objectives for our subjects (e.g., the/a, is/-ed, he/she). Our stimulation of target forms was focused on these targets. In contrast, Hoffman et al. selected no specific goals of this sort and as a result provided general language stimulation. Furthermore, our intervention procedures were employed in conversational contexts, whereas Hoffman et al. administered their procedures in a narrative discourse task.

The important question is whether these and other differences can account for a pattern of results that is entirely different from that found for the subjects of Hoffman et al. (1990). For two reasons, we believe that they cannot. First, like the approach of Hoffman et al., our intervention took place in contexts in which communication was foremost. The goal of our intervention was not simply the production of new language forms and/or more consistent use of newly acquired forms. Rather, we sought the children's use of these forms in pragmatically appropriate contexts for the purposes of communication. This is evidenced clearly in our decision to evaluate intervention gains by examining data collected exclusively in dyadic play interactions between the subjects and their primary caregivers rather than from less naturalistic probes. Thus, it cannot be claimed that our intervention targeted a point too far downstream in the child's sentence formulation processes to expect generalization to phonology via the same mechanisms as those presumed to have been functioning in the Hoffman et al. case. Second, although the specific aspects of grammar that were modified over the intervention period no doubt varied dramatically from child to child, our investigation stands as a clear demonstration that the sentences the subjects produced following 5 months of intervention were developmentally more mature than those they produced before intervention. No matter how this effect was achieved, this is precisely the condition under which changes in phonology have been predicted to occur. Why then, did we not observe changes in phonology like those observed by Hoffman et al.?

**Differences in subjects.** As pointed out by Tyler and Watterson (1991), one likely explanation is that the subject who received language intervention in the Hoffman et al. (1990) study was relatively mildly impaired compared to the subjects in the present investigation. It is reasonable to speculate that more severe phonological impairments would be less amenable to the indirect influence of broader language interventions that target grammatical and discourse patterns. This hypothesis receives limited support from the studies of Tyler and her colleagues (Tyler & Sandoval, 1992; Tyler & Watterson, 1991).

Examination of the performance of our most mildly impaired subjects yielded no evidence to support this hypothesis, however. Children with milder phonological impairments made large improvements in grammatical expression, but in general they made only limited gains in phonology. One of the three children who made a significant improvement in speech sound production as measured by PCC exhibited no change in DSS. There is simply no evidence from our study to support the claim that an effective intervention focusing on expressive language will have a positive influence on the phonological production of the treated children.

**Differences in research methods.** The remaining potential explanations of differences between the results of our investigation and those of Hoffman et al. (1990) are based on research methodology. The generalized results reported by

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It should be noted as well that the subjects studied by Matheny and Panagos also appear to have had mild impairments. The average PAT error scores reported for Matheny and Panagos' subjects (Table 3, p. 59) are within 1 SD from the mean for male subjects in the same age range from the normative sample used for the PAT (Pendergast, Dickey, Selmar, & Soder, 1984, p. 15). Therefore, phonological skills of many of the subjects in this study must have fallen well within the normal range.
Hoffman et al. were observed on a single subject. This subject's pattern of results was compared to that of only one additional subject. In our view, the brief period of intervention, 6 weeks, and the collection of three pre- and post-intervention baselines are factors that reduce the possibility that the general effects of the language intervention in this study occurred simply by chance or as the result of maturation unrelated to the intervention. Still, there were no experimental controls employed that can adequately rule out the possibility that the pattern of gains observed was spurious and essentially not replicable. In our investigation, a few subjects who improved in grammatical expression also made improvements in consonant production (cf. S12 and S38 in Table 4). But this finding cannot be interpreted as an intervention effect because (a) this pattern was observed for a small minority of subjects, and (b) there is nothing in the profiles of these subjects that suggests to us that an aptitude by intervention effect occurred.

Conclusions

Our experiment yielded strong evidence that our interventions were responsible for significant increases in the development of complexity of the sentences produced by our subjects (see also Fey et al., 1993). But we found no support for our prediction that effective facilitation of grammar would lead to spontaneous improvements in phonological output in children with speech and language impairments. Consequently, we believe that the strategy of trying to improve intelligibility by focusing intervention on grammar (or even broader discourse patterns) is not defensible at this time, at least for children in the age and severity ranges studied in this investigation. This strong position does not rule out the possibility of developing programs for speech- and language-impaired children in which primary emphasis is placed on facilitating grammar or more complex propositional structure or story grammar elements. For example, Hoffman (1992) discussed a “whole language” approach that includes intervention episodes focusing on the child's speech sound errors when they result in miscommunication in naturalistic contexts. This strategy has long been a part of many intervention approaches (Backus & Beasley, 1951; Winitz, 1975) and may be highly effective in many cases. As pointed out by Winitz (1975) and Hodson and Paden (1983), however, such techniques tend to be successful only when the target sounds are present in the child's phonetic inventory. If the child cannot produce the target sound, efforts to stimulate the sound in context may be overly frustrating for both child and clinician. More importantly, the longer and more frequent these clarification episodes become, the more they interfere with the fundamental task at hand: communication. In these cases, more direct focus on phonology may be necessary.

The rejection of our clinical hypothesis that spontaneous gains in consonant production would result from intervention-induced changes in grammar should not be taken as a rejection of the claims that grammar and phonology interact in important ways in normal and abnormal development or that this relationship may play an important role in intervention decisions. There is a great deal of evidence that weaknesses or constraints in either phonology or grammar can influence a child's spontaneous linguistic performance (e.g., Donahue, 1986; Leonard et al., 1988; Masterson & Kamhi, 1992; Matthei, 1989; Paul & Shriberg, 1982). Our study examined only the effects of one form of language intervention that anticipated phonological effects through indirect, central processes. Other more direct mechanisms should be explored in future investigations. For example, it may be that input stimulation focused systematically on grammatical forms containing target speech sounds (e.g., is, and plural, possessive, third person verb suffixes for a child who stops final sibilants) stimulates correct production of specific classes of phonological targets (e.g., sibilants). Such an effect would depend on a much more peripheral phonology/grammar relationship than that posited in the present study or in the earlier study of Hoffman et al. (1990). Furthermore, detection of this type of effect probably would require a different experimental methodology than the group design we employed.

Furthermore, evidence also exists suggesting that when there is a direct link between a child's failure to realize existing grammatical knowledge and phonologic form, intervention focusing on specific phonological patterns may yield spontaneous improvements in morphophonological expression (Fey & Stalker, 1986). We have dealt successfully with several preschoolers who were highly unintelligible by concentrating our earliest intervention efforts on phonology (see also Hodson, Nonomura, & Zappia, 1989; Matheny & Pangan, 1978). Thus, when phonology is emphasized in intervention and phonological constraints on production are relaxed, spontaneous changes in children's grammatical expression may be observed. In our experience, however, even when such interventions have been successful, additional language intervention is necessary to assist children in acquiring language forms and operations that are not directly limited by surface phonetic characteristics (e.g., Fey & Stalker, 1986).

For most children who have impairments in both speech and language, we believe that some clinical attention must be focused directly on both areas. There are several possible strategies by which this might be accomplished. For example, phonological and grammatical objectives might be treated simultaneously. Alternatively, either phonology or grammar could be targeted for an initial period of intervention. Then, intervention focus could be shifted to the other area.

Hodson et al. (1989) presented a case in which it appeared that the strategy of simultaneous intervention overwhelmed the child, who eventually responded better to a phonology-only approach. Two subjects reported by Tyler and Sandoval (1992), however, responded to a simultaneous approach by making rapid and highly significant positive changes in both phonology and average sentence length. We are unaware of any attempts to evaluate the effectiveness of an approach that involved planned shifts from periods of grammatical emphasis to emphasis on phonology, or vice versa. Although further research into the effectiveness and efficiency of these approaches is needed, it is unlikely that any one strategy will be better for all children with both speech and language impairments.
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Effects of Grammar Facilitation on the Phonological Performance of Children With Speech and Language Impairments

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