In this study, 48 children with moderate or severe delays in phonological ability received treatment for four phonemes, selected in accordance with either traditional or nontraditional target-selection criteria. Children who received treatment for phonemes that are early developing and associated with greater productive phonological knowledge showed greater progress toward acquisition of the target sounds than did children who received treatment for late-developing phonemes that were associated with little or no productive phonological knowledge. Between-group differences in generalization learning were not observed. Child enjoyment of therapy did not differ between groups, but parental satisfaction with treatment progress was greater for children in the traditional group than for children in the nontraditional group.

**KEY WORDS:** phonological disorders, phonological treatment, treatment efficacy, target-selection strategy

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Treatment of delayed phonological skills can be a slow and gradual process. For example, Diedrich and Bangert (1980) found that school-age children who misarticulated /s/ or /r/ received an average of 32 treatment sessions spread out over a 10-month period. Furthermore, a quarter of these children had not achieved mastery of the targeted phoneme at the end of the school year.

Efforts to improve the efficiency of therapy for phonological disorders have focused on most aspects of the treatment process, including treatment approach (Gierut, 1990; Monahan, 1986; Rvachew, 1994), number of words to target in therapy (Elbert, Powell, & Swartzlander, 1991), discharge criteria (Diedrich & Bangert, 1980; McKercher, McFarlane, & Schneider, 1995), and target-selection criteria (Bernhardt & Gilbert, 1992; Gierut, Elbert, & Dinnsen, 1987). The purpose of the study reported in this paper was to examine the relative efficiency of different target-selection criteria, using a two-group experimental design. As an introduction to the study, we will discuss issues related to target selection and review some recent treatment efficacy studies.

Children who demonstrate a moderate or severe delay in phonological development will misarticulate many speech sounds. Because it is typical to treat only two or three phonemes at any one time, the clinician must decide which sounds to target for treatment. Traditionally, clinicians have been advised to target a phoneme that is likely to have the most impact on intelligibility and that is the most likely to show early improvement. Rapid improvement in production accuracy is expected to occur when the sound is stimulable, produced correctly on an inconsistent basis, or “early developing” according to normative data. Two basic assumptions underlie these criteria: (1) It is important that
the child not feel frustrated or discouraged by the therapy process. (2) The acquisition of early-developing phonemes is a necessary prerequisite for the acquisition of later-developing phonemes. (For further discussion, see Gierut, Morrisette, Hughes, & Rowland, 1996; Creaghead, Newman, & Secord, 1989.)

Recently, new target-selection criteria have been proposed that are based on linguistic theories about the structural relationships between phonemes, rather than on developmental stage models of phonological acquisition. Gierut et al. (1996) described two single-subject studies involving 9 children that investigated “non-developmental” target-selection criteria—specifically, clinicians were advised to target sounds that represent least-productive phonological knowledge and relatively late expected age of mastery. Study I led them to conclude that “It seemed to be just as easy for a child to learn to produce early-acquired treated phonemes as it is to produce later-acquired treated phonemes...” (p. 226). In Study I the quasi-experimental, alternating-treatments design was used with 3 children. Each child received treatment for two different consonants, one of which was described as early developing and one of which was described as late developing, in reference to the child’s chronological age. In each case it was reported that the child demonstrated greater treatment progress for the late-developing sound.

In Study II of Gierut et al. (1996), a multiple baseline design was used with 6 subjects. Each of 3 subjects received treatment for one early-developing consonant, selected on the basis of the normative data reported by Smit, Hand, Freilinger, Bernthal, and Bird (1990). Onset of treatment was staggered across subjects, and both within-class and across-class generalization was monitored in addition to progress for the treated sounds. The same procedure was used with three more subjects, except that these children received treatment for a late-developing consonant. A treatment effect was observed for 5 of the 6 children. They concluded that “treatment of later-acquired phonemes was the only condition that resulted in further and immediate system-wide improvements as characterized by across-class generalization” (p. 226). Unfortunately, the research design employed in Study II could not directly test the hypothesis because the comparison of the experimental conditions of interest (treatment of early- versus late-developing targets) was made across subjects rather than within subjects.

Gierut et al. (1996) cited three other publications in support of the general principles that underlie the non-traditional approach. These studies vary with respect to the specific hypothesis, the outcome measures, and the procedural details. However, in every case the general hypothesis was that teaching more complex sounds would lead to greater overall change in the child’s phonological system than would teaching less complex sounds. Gierut, Elbert, and Dinsen (1987) selected targets on the basis of Productive Phonological Knowledge. Target consonants for each child were a “knowledge type” that reflects the child’s production accuracy. Type 1 indicated “most productive knowledge” (the sound was produced correctly all of the time), and Type 6 indicated “least productive knowledge” (the sound was produced incorrectly all of the time). The authors concluded that treatment beginning with least knowledge “facilitated the accurate and generalized use of sounds across the entire sound system,” and they recommend that treatment programs “be structured such that sounds of which the child has least knowledge are treated first” (p. 475).

Tyler and Figurski (1994) used Dinsen, Chin, Elbert, and Powell’s (1990) “implication hierarchy” to select targets. This hierarchy assigns distinctive features to one of the levels A through E, where E is the highest level and A is the lowest. The presence of a feature at a given level implies the presence of a feature at each of the lower levels on the hierarchy. The child who was treated for a phoneme representing the higher-level feature acquired more new phones than the child who received treatment for a phoneme representing a lower-level feature.

Powell, Elbert, and Dinsen (1991) assessed each child’s stimulability for the target phoneme /r/. The children who were unstimulable for this sound were expected to show the most generalization to untreated sounds. A fully experimental multiple baseline across behaviors design was used with 6 subjects, 2 of whom were stimulable for /r/ and 4 of whom were not. The 2 stimulable children made better progress in treatment and generalized /r/ to untreated words, whereas the children who were not stimulable for /r/ made very limited progress with this sound. Other sounds were also monitored during the course of the treatment program. Performance gains were sometimes observed for stimulable sounds even when they were not treated.

Although the studies discussed above described data for 23 children in total, they provide less-than-compelling support for the use of nondevelopmental target-selection criteria. The research designs employed are characterized by a number of weaknesses, two of which will be discussed here.

First, all of these studies used a variation on the multiple-baseline design. These research designs demonstrate experimental control when the child’s performance improves for the target sound but remains stable and low for the untreated sounds (McReynolds & Kearns, 1983). However, the investigators expected, and observed, improved performance for untreated phonemes, even when the treated phoneme was not acquired. We feel that the findings of these single-subject studies need
to be replicated in larger sample experimental investigations before recommending application of nontraditional target-selection procedures in clinical settings.

Second, the traditional approach assumes that it is important for the child to experience early success, with the expectation that this will enhance the child's self-esteem and the family's satisfaction with the therapy process. Studies regarding the nondevelopmental approach do not address these issues. Many of the children in these studies made slow progress for the target sound. It is not known whether the nondevelopmental approach increases the probability of failure to acquire the treated phoneme or whether such failure affects the child's enjoyment of therapy.

The purpose of the study reported here was to investigate the relative effectiveness of two different sets of target-selection criteria when implemented within the context of treatment procedures that were commonly used by clinicians at our facility. For all children in this study treatment targets were determined on the basis of the child's productive phonological knowledge for each potential target as well as the expected age of mastery for each potential target. Some children received treatment for phonemes that represented most productive phonological knowledge and/or were relatively early developing. This group will be referred to as the ME (most knowledge, earliest developing) group. The remaining children received treatment for the phonemes for which they had the least productive phonological knowledge and which are relatively late developing. This group will be referred to as the LL group (least knowledge, latest developing).

This study was not a direct replication of the studies that were summarized above in that there were three significant procedural differences. First, the previous studies employed single-subject designs with significant differences in target-selection criteria, treatment procedures, and outcome measures across children. The study reported here employed a two-group design, with 48 children randomly assigned to either the ME group or the LL group. Target-selection criteria were held strictly constant within groups. Treatment procedures were held constant within and across groups. Outcomes were assessed by research assistants who were blind to the child's group assignment.

Second, previous studies focused on specific variables that contribute to target-selection decisions (e.g., productive phonological knowledge, stimulability, or developmental level of the target sound). However, clinicians integrate information across a number of variables when selecting targets to treat. As noted above, traditional criteria would lead a clinician to select a target phoneme that is stimulable and early developing. Gierut et al. (1996) suggested that eight different, although overlapping, variables might be considered when applying nontraditional criteria (stimulability, phonetic complexity, acoustic-phonetic differentiation, markedness, productive phonological knowledge, reduction of homonymy, phonemic complexity, and developmental sequence of acquisition). For this study, we employed a target-selection process that combined information about consistency of production of the potential targets with expected age of mastery for each potential target in a fashion that could be replicated across time and subjects.

Finally, the previous studies involved a single target-selection point, and targets were treated one at a time. For the purpose of this study, we aimed to replicate treatment procedures that are consistent with our own clinical practice. Clinicians in our facility who specialize in the treatment of phonological disorders reported that they most commonly use a combination of the horizontal and cycles goal-attack strategies. Therefore, in this study the participants were treated for two sounds during a 6-week period. The children's phonological skills were then reassessed and two new targets were selected and treated during the second 6-week treatment block. At the end of the 12-week treatment program, progress was assessed for treated and untreated consonants.

To reiterate, the purpose of the study reported here was to investigate the relative effectiveness of the ME and LL target-selection criteria. The focus of the study was the application of a target-selection process over time, rather than a comparison of performance for specific targets per se. Three types of outcome measures were employed. First, treatment progress for target sounds was assessed. Second, overall changes in phonological ability were examined. Finally, client satisfaction was assessed using both child- and parent-report measures.

**Method**

**Participants**

Forty-eight preschool-age children with moderately or severely delayed phonological skills were referred for participation in this study. These children did not have global delays in language skills but may have had specific areas of difficulty. All 48 children performed within normal limits on a standardized test of receptive language ability. Forty-three children performed within normal limits on a standardized test of expressive language ability (the exact test varied with the referring clinician), whereas 5 children demonstrated expressive syntax skills that were below normal limits. The normal limit was defined as scores that were no less than one standard deviation below the mean. The referring clinician reported that each child passed a hearing screening and oral-peripheral examination.
Children who were accepted as study participants were randomly assigned to the ME and LL conditions (N = 24 for each group). Mean ages of the participants were 51.46 months (SD = 6.02) and 49.63 months (SD = 4.99) for the ME and LL groups, respectively. Mean percentile rankings on the Goldman-Fristoe Test of Articulation (Goldman & Fristoe, 1986) before treatment were 1.33 (SD = 2.29) and 1.23 (SD = 1.67) for the ME and LL groups, respectively. (Percentiles less than one were arbitrarily assigned a value of 0.5 for this calculation.) In the ME group, 19 children fell below the first percentile, whereas the remaining 5 children scored between the second and sixth percentiles. In the LL group, 20 children fell below the first percentile, and the remaining 4 children scored between the second and ninth percentiles. There were no significant differences between groups with respect to these pretreatment descriptive variables.

Procedures

Each child in both groups received an initial assessment (A1) followed by six weekly treatment sessions (referred to collectively as the first treatment block, or B1), a second assessment (A2) followed by six more weekly treatment sessions (B2), and then a post-treatment assessment (A3). The first treatment block targeted two phonemes selected on the basis of the A1 assessment data, and the second treatment block targeted two new phonemes selected on the basis of the A2 results. This sequence of assessment and treatment sessions was completed by each child in no less than 12 weeks and no more than 14 weeks.

Assessment

Each of the three assessment sessions was conducted in the same manner. One of two research assistants administered the Productive Phonological Knowledge Profile (PPKP) using an imitative task. This profile, described by Gierut et al. (1987), is a list of 198 words that assess the child’s ability to produce stops, nasals, fricatives, affricates, liquids, and glides in the initial, medial, and final position of words. With the exception of /h/ and /j/, there are 15 items per phoneme. Each response was scored as correct or incorrect with respect to the target phoneme. Point-by-point agreement between the two research assistants was determined for correct/incorrect coding of 16 randomly selected samples and averaged 91.84% (range: 84% to 96%). Three outcome measures were derived from the PPKP: (1) overall percent correct for all 198 items administered at A3; (2) mean percent correct for phonemes that were categorized as PPK Type 6 (i.e., 0 percent correct) at A1; and (3) number of new phonemes at A3, meaning sounds that improved from PPK Type 6 at A1 to some higher type at A3.

Following administration of the PPKP, the research assistant obtained a sample of conversational speech, using a picture book (Carl Goes Shopping; Day, 1989) as a stimulus. A broad transcription of the conversational sample was scored for Percentage of Consonants Correct (PCC), using procedures described by Shriberg and Kwiatkowski (1982). Coding reliability was determined for 16 randomly selected conversational samples. The mean difference between pairs of PCC scores was 8.39.

At the end of every second treatment session a research assistant asked the child to indicate degree of enjoyment during the session. The child was shown a series of pictographs and asked “How much fun did you have in speech therapy today? Lots of fun, some fun, not much fun, or no fun at all.” The child responded by pointing to the appropriate pictograph.

During the post-treatment assessment (A3), the parent was asked to complete the department’s standard Client Satisfaction Questionnaire. This questionnaire consisted of 15 statements covering different aspects of our service. The parents indicated degree of agreement with each statement, using a 5-alternative Likert scale (see Appendix). Two outcome measures were derived from this questionnaire: overall satisfaction with the treatment program and satisfaction with their child’s progress during therapy.

The research assistants were blind to the child’s group assignment and treatment targets throughout the course of the study. The child’s speech-language pathologist (SLP) was not present during any assessment procedures, and assessments were conducted in locations different from those used for treatment.

Target Selection

Targets were selected jointly by the authors. Targets were selected for the first treatment block using A1 data, using the following procedures. First, type of productive phonological knowledge was determined for each phoneme assessed by the PPKP, using procedures described by Gierut et al. (1987). A description of the types of productive phonological knowledge is shown in Table 1. Within each type, phonemes were rank-ordered by expected age of mastery, using the 90th percentile norms reported by Smit et al. (1990). Two potential treatment targets were selected, on the basis of the child’s PPKP, for each child in the ME and LL groups. ME targets represented most productive phonological knowledge (excepting Types 1, 2, and 3) and earliest age of mastery. LL targets represented least productive phonological knowledge and latest age of mastery. An additional criterion, applied to both groups, was that the two targets differ with respect to manner and/or place of articulation. All targets were taught in word-initial position unless the child had some correct productions in
this word position, in which case the phoneme was targeted in word-final, word-medial, or word-initial cluster contexts. An effort was made to teach target sounds in word positions where the child's pretreatment probe score was 0, even for children in the ME group. For example, if a child in this group produced /k/ with 100% accuracy in word-final position, 20% accuracy in word-medial position, and 0% accuracy in word-initial position, then the /k/ sound would be targeted in the word-initial position. For Block 1 targets, the average pretreatment probe score for the targeted word position was 0.44 for the ME group and 0 for the LL group (out of a possible total of 5 points).

During Block 1 a control target was monitored in order to compare performance gains for treated versus untreated sounds. Control targets were selected according to the same criteria used to select the actual B1 treatment targets. B1 targets were treated for 6 weeks and then the children were reassessed. After the second assessment, two new targets were selected for treatment during the second 6 weeks of therapy, using the criteria and procedures described above, with the additional criterion that the B2 targets be different from B1 targets. (In a few cases two new potential targets were not available and therefore the B1 target was repeated, but in a different word position.) A third assessment followed the second treatment block.

Two examples of the target-selection process are shown in Table 2. The left side of Table 2 shows productive phonological knowledge data for Subject 22, who was assigned to the ME group. The phonemes /t/, /d/ were placed at Type 4. One of these, /t/, was selected as a treatment target. The only other phoneme at Type 4 shared manner of articulation with this target so the phonemes at Type 5 were considered. The earliest developing target at Type 5 that was not a stop was /l/, and thus the two targets selected for treatment during Block 1 were

### Table 1. Description of types of productive phonological knowledge.

<table>
<thead>
<tr>
<th>Type</th>
<th>Description*</th>
<th>Examples from Subject 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Produced correctly in all word positions for all morphemes.</td>
<td>/p/ probe score 15/15; e.g., pig = [piɡ], soap = [sɒpi], cup = [kʌp]</td>
</tr>
<tr>
<td>2</td>
<td>Produced correctly in nearly all morphemes but alternations between the target and another sound observed for some morphemes (optional rule).</td>
<td>/ɡ/ probe score 14/15; e.g., catching = [kaɪt] on probe but [kɛt] in conversational sample.</td>
</tr>
<tr>
<td>3</td>
<td>Produced correctly in nearly all morphemes but some “fossilized” forms always produced incorrectly.</td>
<td>No examples for this subject</td>
</tr>
<tr>
<td>4</td>
<td>Produced correctly in one or more word positions but consistently in error in other word positions.</td>
<td>/k/ probe score 10/15; e.g., cup = [kuːp], rocky = [wʌk], sock = [saːk]</td>
</tr>
<tr>
<td>5</td>
<td>Inconsistently correct in one or more word positions and consistently incorrect in other word positions.</td>
<td>/l/ probe score 2/15; e.g., laugh = [laːf], hilly = [hiːl], nail = [naːl]</td>
</tr>
<tr>
<td>6</td>
<td>Produced incorrectly in all word positions and all morphemes.</td>
<td>/θ/ probe score 0/15; e.g., thumb = [θʌm], toothy = [θʌti], bath = [baːθ]</td>
</tr>
</tbody>
</table>

The control sound that was monitored during this period was /k/. After 6 weeks of treatment, the treatment target /l/ and the control sound /k/ both made 10-point gains, improving from Type 4 to Type 1. The other Type 4 sound /d/ also improved to Type 1. The second treatment target /l/ improved from Type 5 to Type 4, along with several untreated sounds that were placed at Type 5 or 6 at A1. The same traditional target-selection criteria that were applied at A1 were used to select Block 2 treatment targets from the A2 data. Again the Type 4 sounds were rank-ordered according to developmental level. Using the same target-selection criteria, /p/ and /v/ were selected as targets (/k/ being excluded). After 6 weeks of treatment targeting /k/ this child was reassessed. The A3 data show that all consonants had been mastered except /l, v, r/, which were placed at Type 4, and the interdental fricatives, which were placed at Type 5.

Subject 43 was randomly assigned to the LL group. At A1, three consonants were placed at Type 4 (/p, d, v/), and all remaining error sounds were placed at Type 6. The Type 6 phonemes were rank-ordered by expected age of mastery, and the two latest-developing sounds were selected as treatment targets (/r, /l/). The affricate /k/ was selected as the control sound because it was the third potential Type 6 target on the developmental hierarchy. After 6 weeks of treatment the sounds /p, d, v/ had improved to Type 1, although they were not treated. The treatment targets (/r, /l/) did not improve, and neither did the control target /k/. In fact, all sounds that were placed at Type 6 before treatment remained at this level after the first 6-week treatment block. New targets were selected for treatment during Block 2. The same criteria were applied, except that B1 targets were excluded as potential targets. The consonants /l, /j, /d/ are at the same developmental level, and /l/ was selected as the treatment target. The liquid /l/ was selected as the second treatment target because of the difference in manner of articulation in comparison with the first target /l/. The phonemes /l, /l/ were then treated for 6 weeks. The A3 assessment revealed no change in Subject 43's production of any of the phonemes placed at Type 6 during the A2 assessment.

These two examples demonstrate two important "side-effects" of the target-selection process that was employed in this study. First, the "difficulty level" of the targets changes over time, and thus there is some overlapping of targets for the two groups at A2. This occurs because the sounds that were treated during Block 1 were excluded as potential Block 2 targets. Thus it was inevitable that Block 2 targets would be "easier" than Block 1 targets for children in the LL group, but "harder" than Block 1 targets for children in the ME group. Second, the individualized application of the target-selection criteria leads to the selection of the same phoneme for children in both groups in some cases. Both subjects 43 and 22 were treated for /l/ during the second treatment block. However, this target was a Type 6 sound for the child in the LL group, but the same target was a Type 5 sound for the child in the ME group.

The process leads to some subjective decisions because multiple targets can be placed at the same PPK type and age level. However, the process did result in clear differences in the nature of the treatment targets across groups. The targets selected for the ME group for treatment during the first block had an average expected age of acquisition of 53 months (SD = 17) according to the Smit et al. (1990) norms. The mean type of PPK was 4.56 (SD = 0.74). These targets typically represented Type 4 productive phonological knowledge, although earlier-developing Type 5 and Type 6 sounds were selected when no potential Type 4 phonemes were available. The most frequently occurring targets were /k/ and /l/ (see Table 3). Expected age of mastery for the LL group's Block 1 targets averaged 88 months (SD = 11), and these targets typically represented Type 5 productive phonological knowledge (M = 5.96, SD = 0.20). The most frequently selected targets were /s/ and /l/. Mean expected age of mastery for Block 2 targets was 64 months (SD = 19) and 77 months (SD = 15) for the ME and LL groups, respectively. Mean type of PPK for Block 2 targets was 5.17 (SD = 0.83) and 5.71 (SD = 0.62) for the ME and LL groups, respectively. T tests were used to compare target characteristics (PPK Type and Expected Age of Mastery) for Block 1 and Block 2 targets both within and across groups. All comparisons indicated significant differences (all t > 2.66, all p < .05).

**Treatment**

Each child was treated by one of five SLPs, each with CSLPA and/or ASHA certification. The numbers of

| Table 3. Frequency of target phonemes by treatment block and group. |
|---------------------------------|---|---|---|---|
|                                | ME Group |   | LL Group |   |
|                                | B1  | B2 | B1  | B2 |
| /w/                            | 2   | 0  | 0    | 0  |
| /g/ /b/                        | 3   | 0  | 0    | 0  |
| /l/                            | 0   | 0  | 0    | 0  |
| /k/ /g/                        | 11  | 13 | 1    | 5  |
| /l/                            | 0   | 0  | 0    | 0  |
| /l/ /v/                        | 16  | 4  | 0    | 0  |
| /l/                            | 0   | 0  | 8    | 10 |
| /l/ /z/                        | 1   | 6  | 12   | 4  |
| /l/                            | 2   | 7  | 4    | 8  |
| /l/ /v/                        | 2   | 5  | 2    | 6  |
| /l/                            | 5   | 9  | 3    | 12 |
| /l/                            | 1   | 1  | 18   | 3  |
children treated by each clinician, as a function of group, are shown in Table 4.

Sets of 10 picture cards were constructed for each phoneme and word position targeted. Obviously the picture card set varied from child to child depending upon the child's treatment targets. However, picture cards were constant for a given target (i.e., all children who were taught /l/ in word-initial position practiced the same 10 words). Two probe words were included in the picture card set in an effort to avoid floor effects; a minimum indication of a treatment effect would be correct production of treated words when probed by an unfamiliar listener. The remaining 8 words consisted of 6 monosyllabic words and 2 multisyllabic words that were not replicated on the PPK probe.

During each treatment block the child received 6 weekly treatment sessions, each 30 to 40 min in duration. Treatment procedures, activities, and materials were held strictly constant both within and across groups and clinicians. The treatment procedures were designed to lead the child through seven steps: imitated syllables, imitated words, spontaneous words, imitated patterned sentences, spontaneous patterned sentences, imitated sentences, and spontaneous sentences. Both target phonemes were treated during each session, with the order alternating from session to session. Each sound was targeted individually in separate 15-min periods. For each target sound the child engaged in a game activity and a drill activity. An example of a game activity is “bowling.” The child was given a ball to bowl at picture cards propped against pins. A child working at Step 3 (spontaneous words) would be asked to name the picture before bowling the ball. A child working at Step 5 (spontaneous patterned sentences) would announce “I’m going to hit the______” before each throw. One game activity during each session was a craft that served as the child’s homework for that week. The phoneme targeted by the homework activity alternated from week to week. An example of a craft activity is the construction of postcards and a mailbox. The game activity was followed by two 10-trial drills, in which the child was required to name or talk about each of the 10 picture cards, with the exact instructions to the child depending upon the step achieved during the previous treatment session. The child was moved to the next step whenever a score of 8 correct out of 10 attempts was achieved. At the end of the 6-week treatment block the SLP’s response forms were used to determine the highest step achieved by the child for each target phoneme.

Results

The relative impact of the ME and LL target-selection criteria was examined for three kinds of outcomes: (1) treatment progress, (2) generalization, and (3) clinician satisfaction. All statistical analyses involve analysis of variance, calculated using Minitab’s “general linear model” function. When conducting these ANOVAs, SLP was entered as a separate variable in order to control for clinician effects. Table 4 shows the number of children treated by each SLP, along with the mean and standard deviation of treatment progress for those children. Treatment progress was measured by the highest step achieved in therapy, averaged across all four targets and both treatment blocks for the purpose of this analysis. Across clinicians, groups, targets, and treatment blocks the mean highest step achieved in therapy was 3.86 (SD = 1.99). A 2 × 5 analysis of variance was performed with group (ME or LL) entered as a fixed variable and SLP entered as a random variable. A significant effect of SLP was not observed [F(4, 38) = 5.17, p = .07]. The interaction of group with SLP also was nonsignificant [F(4, 38) = 1.16, p = .34]. Nonetheless, children treated by SLP 4 achieved a level of treatment progress that was more than one standard deviation less than the mean for all clinicians, and consequently all tests for the effect of target-selection criterion on outcomes control statistically for SLP by including the variable SLP as a covariate.

Effect of Target-Selection Criterion on Treatment Progress

In each group 24 children received treatment for four target sounds. Children in the ME group achieved Step 7 (spontaneous sentences) for 38.00% of those targets and failed to achieve Step 1 (imitated syllables) for 11.46% of the targets. Children in the LL group achieved Step 7 for 17.00% of the targets and failed to achieve Step 1 for 34.38% of the targets. On average, the highest step achieved in therapy was 4.73 (SD = 2.01) for children in the ME group and 2.83 (SD = 2.27) for children in the LL group, with ANOVA revealing a significant effect of both group [F(1, 46) = 20.13, p = .004] and treatment block [F(1, 46) = 4.16, p = .047]. Although there was a significant group-by-block interaction [F(1, 46)}
between-group differences remained significant for each treatment block. The mean highest step achieved in therapy for the first treatment block was 4.92 (SD = 1.89) and 1.96 (SD = 1.83) for the ME and LL groups, respectively [t(45) = 5.52, p < .001]. The mean highest step achieved for the second treatment block was 4.74 (SD = 2.03) and 2.83 (SD = 2.27) for the ME and LL groups, respectively [t(45) = 4.32, p < .001].

The highest step achieved in therapy for each treatment target is shown in Table 5. This table shows that treatment progress was generally better for earlier-developing than for later-developing phonemes and for sounds associated with greater productive phonological knowledge than for Type 6 targets.

Changes in probe score between A1 and A3 were examined for the four treatment targets. Generalization of learning for treated phonemes from treatment sessions to the post-treatment probe of productive phonological knowledge was significantly greater for the ME group than for the LL group [F(1, 42) = 14.12, p = .001]. The probes for each target contained 15 items, and thus the maximum amount of change possible across all four targets was 60 points. Summed across the probes for the four treatment targets, the ME group achieved a mean change score of 15.54 (SD = 9.78), whereas the LL group achieved a mean change score of 6.46 (SD = 8.03). These scores were distributed evenly about the mean, with the mean and the median both approximately 15 for the ME group (skewness = 0.2). The median score was considerably lower than the mean for the LL group, however (skewness = -0.71, median = 3.50).

The mean probe scores for the B1 and B2 treatment targets at each of the three assessments are shown in Figure 1. Changes in performance over time will be discussed for the Block 1 targets first. The mean change in probe score for the ME group B1 targets was 2.92 during the first block when these phonemes were treated and 1.15 over the second block, indicating continued improvements but at a slower rate after treatment was withdrawn. The LL group showed a slower rate of improvement for B1 targets during the first block, with a mean change in probe score of 1.73. When treatment was withdrawn for these targets during B2, A3 probe performance for these phonemes declined, with a mean change score of -0.34 for this block.

Turning to Block 2 targets, Figure 1 shows that the mean probe score for the ME group increased by 1.10 points during the first block, before the onset of treatment for these phonemes. Rate of progress for the B2 targets improved during the second block when treatment was introduced for these sounds, as shown by a mean change score of 2.58. Mean change in probe score for the LL group B2 targets was -0.40 during the first

### Table 5. Mean highest step achieved in therapy (number of times targeted) by target sound.

<table>
<thead>
<tr>
<th>Target sound (age of 90% mastery)</th>
<th>Type of productive phonological knowledge</th>
<th>Mean for age category</th>
</tr>
</thead>
<tbody>
<tr>
<td>/b/ (3;0)</td>
<td>4.00 (1)</td>
<td>4.00</td>
</tr>
<tr>
<td>/p/ (3;0)</td>
<td>6.33 (3)</td>
<td>5.00</td>
</tr>
<tr>
<td>/m/ (3;0)</td>
<td>4.00 (1)</td>
<td>4.00</td>
</tr>
<tr>
<td>/w/ (3;0)</td>
<td>7.00 (1)</td>
<td>7.00</td>
</tr>
<tr>
<td>/h/ (3;0)</td>
<td>7.00 (1)</td>
<td>5.10</td>
</tr>
<tr>
<td>/t/ (3;6)</td>
<td>7.00 (3)</td>
<td>7.00</td>
</tr>
<tr>
<td>/l/ (3;6)</td>
<td>3.60 (5)</td>
<td>4.09 (11)</td>
</tr>
<tr>
<td>/l/ (3;6)</td>
<td>6.33 (3)</td>
<td>4.25 (4)</td>
</tr>
<tr>
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<td>2.33 (3)</td>
<td>6.20 (5)</td>
</tr>
<tr>
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<td>3.50 (6)</td>
<td>3.88</td>
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<tr>
<td>/t/ (5;0;6;0)</td>
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<tr>
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<td>3.36 (14)</td>
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<tr>
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<tr>
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<td>5.07 (7)</td>
</tr>
<tr>
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<td>6.50 (2)</td>
<td>3.94 (16)</td>
</tr>
<tr>
<td>/s/ (7;0;9;0)</td>
<td>3.67 (3)</td>
<td>3.57 (14)</td>
</tr>
<tr>
<td>/z/ (7;0;9;0)</td>
<td>2.00 (1)</td>
<td>3.00 (2)</td>
</tr>
<tr>
<td>/v/ (8;0)</td>
<td>4.00 (3)</td>
<td>0.39 (18)</td>
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</tbody>
</table>
| Mean for PPK Type               | 4.62                                     | 5.00                  | 3.06
treatment block. After treatment was introduced for these targets, the mean change in probe score increased to 2.27.

In order to demonstrate that changes in phonological abilities are due to treatment rather than maturation, it was necessary to make some within-subject comparisons of phonological learning for specific phonemes. For the first comparison, a “control target” was selected for each child for the first block of treatment. Control targets were selected according to the same criteria used to select the actual B1 treatment targets (see Table 2 and the Method section for examples). A2 scores on the PPKP were examined for change in production accuracy for the treatment targets and control sound, relative to A1 performance. The mean (and standard deviation) of the change scores for treated targets were 2.92 (2.97) and 2.00 (2.32) for the ME and LL groups, respectively. The mean (and standard deviation) of the change scores for control targets were 0.83 (3.17) and 1.08 (2.91) for the ME and LL groups, respectively. A significant effect of target (Treatment vs. Control) was observed \( F(1, 46) = 7.54, p = .009 \), but there was no interaction of group and target type \( F(1, 46) = 1.14, p = .29 \).

In a second effort to demonstrate treatment effects, changes in PPKP scores for B2 targets from A1 and A2, when B2 targets were not treated, were compared with changes from A2 to A3, when these targets were treated. The mean (and standard deviation) of the change scores from A1 to A2 were 1.23 (2.57) and –0.40 (1.78) for the ME and LL groups, respectively. The mean (and standard deviation) of the change scores from A2 to A3 were 2.71 (2.54) and 2.08 (2.90) for the ME and LL groups, respectively. The observed improvement in production accuracy for Block 2 treatment targets was significantly greater during the period when these phonemes were treated than during the previous 6-week period when other sounds were treated \( F(1, 46) = 14.54, p < .001 \). There was no interaction of block with group \( F(1, 46) = 0.93, p = .34 \).

**Effect of Target-Selection Criterion on Generalization**

Percent correct on the PPKP and PCC in conversation were expected to reflect generalization of treated phonemes (a) from treated to untreated words; (b) from treated to untreated word positions; (c) from treated phonemes to untreated phonemes; (d) from structured activities to conversation; and (e) from familiar conversational partners, such as the clinician, to the research assistant, an unfamiliar listener.

Because there were no significant differences between groups in pretreatment percent-correct on the PPKP or in PCC, these global measures were assessed in relation to raw scores during the A3 post-treatment assessment, yielding no significant differences between groups. For the ME group, mean scores on the PPKP were 52.9 (SD = 16.6) and 62.35 (SD = 16.74) percent correct for the A1 and A3 assessments, respectively. Gain scores for this group varied from –5.3 to 23.9 percent correct. For the LL group, mean scores on the PPKP were 54.2 (SD = 11.3) and 60.48 (SD = 11.48) percent correct for the A1 and A3 assessments, respectively. Gain scores for this group varied from –4.33 to 20.74 percent correct. For the ME group, mean PCC was 60.3 (SD = 13.6) and 62.62 (SD = 12.0) percent correct for the A1 and A3 assessments respectively. Gain scores for this group varied from –18.08 to 22.34. For the LL group, mean PCC was 62.37 (SD = 8.36) and 64.00 (SD = 11.10) for the A1 and A3 assessments, respectively. Gain scores for this group varied from –10.36 to 17.39.

The overall measures of generalization learning did not reveal significant differences between groups. Therefore, we examined changes in probe performance for certain specific phonemes. First, we examined PPKP results at A1 and A3 in order to identify the number of new sounds that each child added to his or her inventory during the 12-week interval. The mean number of new phones identified was 2.21 for the ME group and 2.5 for the LL group, with a range of 0 to 7 phones for each group. Second, mean change scores from A1 to A3 were examined for all Type 6 sounds and for Type 6 sounds excluding any treatment targets. Changes for sounds that were placed at Type 6 during A1 were of particular interest because proponents of nontraditional target-selection practices have hypothesized that treating Type 6 phonemes is necessary for inducing spontaneous
improvements in untreated Type 6 sounds. Therefore PPKP performance at A3 was examined specifically for phonemes that were classed as Type 6 at A1; mean percent correct (and standard deviation) was 18.00 (1.61) and 13.00 (1.26) for the ME and LL groups, respectively. When treated targets are removed from this analysis, the mean percent correct (and standard deviations) are 16.00 (1.73) and 19.00 (2.39) for the ME and LL groups, respectively. Analyses of variance indicate no significant between-group differences for any of these variables.

**Effect of Target-Selection Strategy on Client-Satisfaction Measures**

The child's rating of enjoyment of therapy was averaged across all responses and both treatment blocks, with higher scores indicating "more fun." The mean ratings were comparable across groups: 3.73 (SD = 0.43) for the ME group and 3.81 (SD = 0.32) for the LL group [F(1, 42) = .53, p = .47]. Parent satisfaction with the treatment program overall also was not significantly different between groups, when each parent's responses were averaged across all 15 items of the questionnaire shown in the Appendix. Group mean scores on this questionnaire were 4.37 (SD = .31) and 4.31 (SD = .42) for the ME and LL groups, respectively [F(1, 39) = 0.64, p = .43]. Parent satisfaction with treatment progress did differ between groups, however, with mean satisfaction ratings being 4.3 (SD = 0.70) and 3.91 (SD = .75) for the ME and LL groups, respectively [F(1, 39) = 4.75, p = .035]. (See items 5 and 13 of the questionnaire shown in the Appendix.)

**Discussion**

In this study, 48 children with moderate or severe delays in phonological ability received treatment for four phonemes, selected in accordance with either of two different target-selection criteria. Children assigned to the ME group received treatment for phonemes that are relatively early developing and for which they had the most productive phonological knowledge (excluding sounds mastered by the child). Children assigned to the LL group received treatment for phonemes that are relatively late developing and for which they had least productive phonological knowledge.

**Treatment Progress**

Significant between-group differences were observed for treatment progress, with children in the ME group showing greater progress toward acquisition of the target sounds during therapy sessions than children in the LL group. The between-group difference in treatment progress was particularly marked for the first treatment block. During the second treatment block, treatment progress remained superior for the ME group, but the gap was narrowed considerably. This pattern of converging performance during Block 2 is likely due to the relationship between treatment progress and the developmental level and productive phonological knowledge type of the target sounds, as shown in Table 5. Block 2 targets for the ME group represented later developmental levels and less PPK in comparison with Block 1 targets; on the other hand, Block 2 targets for the LL group represented earlier developmental levels and greater PPK in comparison with Block 1 targets. The improvement in Block 2 performance demonstrated by the LL group does not appear to reflect a facilitative effect of beginning with the most difficult targets. Note, for example, the two children highlighted in Table 2. Both children received treatment for /l/ during the second treatment block. The child in the ME group progressed from PPK Type 6 to PPK Type 4 for this phoneme, but the child in the LL group demonstrated no progress for this phoneme. Although the presence of a facilitative effect of targeting Type 6 phonemes seems unlikely to us given our data, a proper examination of this issue would require a study in which Block 2 targets are held constant across children and the Block 2 treatment time is lengthened.

This outcome is consistent with other studies that show that phonological knowledge is a positive predictor of treatment outcome (e.g., Tyler, Edwards, & Saxman, 1990). This finding also lends some support to Bernhardt and Gilbert's (1992) suggestion that prosodic targets are easier to acquire than segmental targets. When selecting targets on the basis of a nonlinear analysis of the child's phonological system, prosodic targets would be equivalent to the Type 4 targets selected in this study because in both cases the target phoneme is produced correctly in one word position but not produced correctly in another word position. Segmental targets represent features that are absent from the child's system and thus are equivalent to our Type 6 targets.

**Generalization**

The results of our generalization measures also failed to support the use of the nondevelopmental target-selection criteria, as applied in this study. The LL group did not show evidence of greater system-wide changes in phonological ability. In fact, post-treatment performance on our citation form and conversational samples was equivalent for both groups, and both groups demonstrated an addition of approximately 2.5 phonemes to their inventories (with a range of 0 to 7 new phonemes for both groups). This finding is quite interesting, given that LL children were specifically taught to produce Type 6 phonemes,
whereas ME children were more likely to receive treatment for phonemes representing greater productive phonological knowledge. Many children who received treatment for ME targets showed spontaneous emergence of more complex phonemes. For example, at A1 Subject 40 was producing /v, j, m, n, p, b, t, d, g, l/ correctly most of the time in word-initial position. Although /r/ was produced correctly in word-final position, final consonant deletion was pervasive as was stopping of fricatives and affricates. This child received treatment for the early-developing phonemes /p, b, k, t/. At the time of the A3 assessment 6 new phonemes were emerging (/b, f, s, ð, ʃ, t, d, g, l, j, p, ŋ, h, k, f, t, d, g, l, D/ correctly most of the time). Final consonants were consistently included, and stopping was no longer occurring in word-initial position. Overall, production accuracy on the PPK probe improved from 41 to 61 percent correct over the 12-week course of therapy. We are not predicting that all or even most children will show such dramatic changes in their phonologies after a brief period of treatment on early developing sounds; rather we are suggesting that it is not necessary to teach late-developing phonemes in order to achieve spontaneous emergence of other late-developing phonemes.

Research Design Issues

The differences in outcome between this study and those reported by Gierut et al. (1996) and Gierut et al. (1987) are likely due to differences in research design. With respect to “ease of learning” for targets differentiated by age of mastery, there is a great deal of variability between children that may be obscured in small-sample studies. For example, the range in treatment progress for /r/ varied from Step 0 (failure to master /r/ in syllables) to Step 7 (correct production of /r/ in spontaneous sentences) across the 23 children who received treatment for this phoneme. Overall, however, the mean highest step achieved in therapy for /r/ was 0.83, clearly indicating that this phoneme was the most difficult for our participants to learn. In general, phonemes that were earlier developing or associated with greater phonological knowledge showed the most progress in therapy. Furthermore, children in the LL group failed to achieve stimulability, after 6 weeks of treatment, for over one third of the targeted phonemes.

With respect to generalization from treated to untreated phonemes, the problem of between-subject variability also arises. It is possible to find pairs of individual subjects whose performance would appear to support the LL target-selection strategy. When the results for all of the subjects are considered together, a clear relationship between target-selection strategy (as implemented in this study) and generalization learning does not emerge. A primary problem with the study of generalization phenomena is the difficulty in distinguishing between maturation effects and treatment effects. It is possible that the subjects in this study would have added new sounds to their inventories even if they had not been treated or if they had received treatment for different targets. We feel that further study of generalization effects is required, using research designs that clearly distinguish between maturation and generalization.

An additional problem when studying generalization effects is that it is impossible to be sure that the period of study is long enough to capture the relevant data, especially when rates of progress vary so much between children. The period of monitoring in our study and in previous single-subject studies tended to be short (3 to 4 months). Performance on our outcome measures suggested little improvement beyond that observed in treatment sessions. Overall, average gain in mean score on the PPKP was 9.45% for the ME group and 6.28% for the LL group. This small between-group difference was not statistically significant because within-group variance was high. It is possible that this small advantage to the ME group would increase with a longer period of monitoring, leading eventually to statistically significant between-group differences. Alternatively, it is possible that a potential facilitative effect of targeting late-developing sounds requires a longer period of treatment, in which case a longer study might lead to a clearer effect in favor of the LL target-selection strategy. Finally, it seems quite likely that target-selection strategy does not have an effect on generalization outcomes as long as the children receive treatment for multiple phonemes that represent a range of place and manner contrasts.

Implicational Hierarchy

The theoretical foundation for the use of a non-developmental target-selection strategy appears to be the notion of the implicational hierarchy. Dinnsen, Chin, Elbert, and Powell (1990) described the phonetic inventories of 40 children with a phonological disorder in terms of a hierarchy of feature contrasts. These phonetic inventories were used to derive a series of implicational laws. For example, a child with a contrast between strident and nonstrident fricatives present in the phonetic repertoire is expected to show evidence of all lower-level feature contrasts, such as [nasal] and [continuant]. An examination of our subjects’ inventories within this context is clearly beyond the scope of this article, although it is our impression that the children’s inventories typically matched these expectations. We feel that the implicational hierarchy is well supported by the evidence presented in Dinnsen et al. (1990), and it hardly seems controversial to expect a child who produces fricatives to also produce stops. However, the issue is with the clinical implications that flow from their observation of phonetic repertoires. Because the implicational hierarchy


Stimulability

The findings of this study reflect the impact of stimulability on phonological learning because phonemes classed at PPK Type 6 can be considered to be unstimulable by standard definitions (i.e., failure to correctly produce a phoneme after repeated imitative attempts; cf. Lof, 1996). Some studies on the relationship between stimulability and phonological change have been taken as support for a nondevelopmental target-selection strategy. There is ample evidence that children are likely to make spontaneous gains in the production of stimulable phonemes (Powell & Miccio, 1996; Miccio, Elbert, & Forrest, 1999). Figure 1 shows improvement in untreated stimulable phonemes (see probe performance for Block 2 targets assigned to the ME group) but no improvement for untreated unstimulable phonemes (see probe performance for Block 2 targets assigned to the LL group). This figure also shows that rate of progress is increased by treatment for both stimulable and unstimulable phonemes. Unless the treatment of unstimulable phonemes boosts the rate of progress for stimulable phonemes beyond that due to maturation, it is difficult to see how the selective treatment of unstimulable phonemes could be the most efficient procedure.

The strong relationship between stimulability and rate of treatment progress does lead to the conclusion that there is an urgent need to establish the best means of inducing stimulability. Certainly waiting for an absent phoneme to become stimulable does not seem like a reasonable course of action for children with severe phonological disorders, especially when entire sound classes are absent from the child’s system. Miccio and Elbert (1996) described a multiphoneme approach to stimulability teaching that involves play activities with a set of specially constructed picture cards. Rvachew, Rafaat, and Martin (1999) combined phonemic perception therapy with phonetic placement techniques to induce stimulability for target phonemes and then followed up with the cycles approach similar to that described by Hodson and Paden (1983). The efficacy of both of these approaches requires experimental confirmation.

Conclusion

In summary, children made significantly greater progress in therapy when their treatment targets were relatively early developing and associated with relatively greater productive phonological knowledge. In general we would recommend that these criteria be considered when selecting treatment targets. At the same time, however, some children who were treated for “least knowledge, later developing” targets did make progress, and there were no between-group differences on our measures of generalization learning or child enjoyment of therapy sessions. Therefore, we would not avoid targets that are late developing or associated with no productive phonological knowledge when there is some particular motivation for selecting such a target for a given child. Ultimately target-selection decisions must take into account each child’s phonological system, and clinicians must consider a large array of variables. The results of this study provide some information that will help with the decision-making process. We recognize that these recommendations may be valid only for young children and for treatment approaches similar to that employed in this study. It is possible that treatment progress for relatively difficult targets such as /r/ might be improved by the use of an auditory-perceptual (Rvachew, 1994), visual-feedback (Schuster, Ruscello, & Toth, 1995), or a minimal-pairs (Gierut, 1989) approach to treatment. It is also possible that older children may find the later-developing targets easier to acquire. At the same time, older children may be more distressed by a failure to learn the target phoneme than were the young children who participated in this study. Notwithstanding these cautions, the clinician can be reasonably confident that developmentally earlier targets for which the child has relatively greater productive phonological knowledge will be easier for preschoolers to acquire than unstimulable, late-developing phonemes.

Acknowledgments

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Paden for their comments and suggestions. Individual data from this study are posted at www.medserv.mcgill.ca/srvachew.
### Appendix. Parent Satisfaction Questionnaire.

Parents responded to the following statements, using a Likert-type scale with the response alternatives Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, and Strongly Disagree.

1. The SLP has helped me to deal with my child’s speech and language needs.
2. I get enough feedback about my child’s progress.
3. The handouts that are given to me are helpful.
4. I receive a high quality service from the speech-language section.
5. My child’s communication skills are improving as fast as can be expected.
6. The toys and materials used during therapy match my child’s age and interests.
7. The SLP helped me to set treatment goals for my child.
8. In general, I am happy with the service I receive from the speech-language section.
9. The waiting times for assessment and treatment services were acceptable.
10. The SLP is interested in helping me and my child.
11. The type of therapy service I am receiving is well matched to my child’s needs.
12. The SLP plans therapy that is interesting and fun.
13. Therapy has helped my child to communicate better with his/ her family and friends.
14. I feel that I can ask the SLP questions.
15. I am satisfied with the amount of treatment my child and I receive.