ELSEVIER

ENHANCING STIMULABILITY: A TREATMENT PROGRAM

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Recent research on stimulability and generalization suggests that treatment of nonstimulable sounds results in maximum treatment gains (Powell, Elbert, & Dinnsen, 1991). It has also been suggested, however, that nonstimulable sounds are more difficult to teach, especially to young children with very small phonetic inventories. In this article, we describe a treatment program designed to increase the size of the phonetic inventory by "teaching" stimulability. Application of the treatment approach is demonstrated in a case study.

Educational Objectives: The reader will learn to identify a phonetic inventory, components of a stimulation treatment program, and formulate treatment objectives to enhance stimulability.

INTRODUCTION

The number of phonological contrasts in a child's speech is an important factor in intelligibility (Kent, Miolo, & Bloedel, 1994). A child with a very small phonetic inventory necessarily has limited opportunity to produce phonological contrasts. Because a small phonetic inventory limits the number of different utterances a child may produce, homonymy, the use of one form for multiple meanings, results. Increasing the number of sounds in the phonetic inventory increases the number of possible contrasts that can be produced and subsequently increases intelligibility.

Thus, the primary goal of a treatment program for a child with an impoverished phonetic inventory is to increase the number of sounds in the inventory as quickly and efficiently as possible. This, however, has not been the emphasis in traditional approaches to treatment. Traditional approaches have emphasized teaching early developing, stimulable sounds (Secord, 1989). This method emphasized the stabilization of "easy" emerging sounds as a founda-

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tion for the acquisition of "hard" later-developing sounds. Results of more recent treatment research, however, suggest that treatment effects may be maximized by planning for system-wide generalization and strategically teaching the sound(s) that will introduce the most change into the phonological system (Gierut, 1989; Gierut, Elbert, & Dinnsen, 1987).

Dinnsen, Chin, Elbert, and Powell (1990) identified an implicational hierarchy for describing the complexity of phonetic inventories from the least to the most complex. For a child to acquire the features of the most complex inventory (Level E), he or she must first acquire the features of the less complex inventories (Levels A through D). Tyler and Figurski (1994) explored the clinical utility of the implicational hierarchy identified by Dinnsen et al. and found that teaching more complex phonetic distinctions resulted in more sounds being added to the phonetic inventory than did teaching a less complex phonetic distinction. Two subjects with inventories limited to stops, nasals, and glides (Level B) were included in the study. Subject 1 was taught /l/ to distinguish nasals from liquids (a Level D distinction). Subject 2 was taught /s/ to distinguish stops from fricatives (a Level C distinction). Subject 1 added 12 sounds to his phonetic inventory, whereas Subject 2 added 2 sounds to his inventory. In this study, teaching the more complex distinction resulted in a more efficient treatment.

Powell et al. (1991) studied the relationship between stimulability and generalization. Using a sound-specific approach in which one speaks of an individual being stimulable for production of a particular sound but not for another (Powell & Miccio, this issue), these investigators found that stimulability explained the generalization patterns observed during treatment. Sounds that were stimulable were most likely to be added to the phonetic inventory regardless of the sounds selected for treatment. Stimulability was as important a predictor of success following treatment as the treatment itself. The more efficacious treatment program, therefore, would be one that gives priority to nonstimulable sounds. These sounds are not likely to be acquired without direct treatment (Miccio, 1995; Powell et al., 1991).

Other researchers, however, have reported limited success obtaining generalization to nonstimulable sounds even when those sounds are directly targeted (Fey & Stalker, 1986). One rationale for treating stimulable sounds is that nonstimulable sounds are simply too difficult to teach and too frustrating for small children to master. Not only are these children not stimulable for production of sounds missing from their phonetic inventories, but the existing inventory of sounds is extremely limited. If the domain of generalization is limited to stimulable sounds, system-wide generalization cannot be predicted and the phonetic inventory will remain relatively small despite extensive treatment. For the results of research on stimulability to be applied successfully in the clinic, treatment strategies to address these problems must be developed.

In addition to these factors, implementation of PL 94-457 and the subsequent emphasis on early intervention has resulted in the identification of children with phonological disorders at younger ages (Stoel-Gammon, 1994). Toddlers may not readily respond to conventional assessment and treatment methodologies despite the ability to imitate sounds they do not use (Tyler, this issue). Children are more likely to produce a target sound when they are attending to and interested in its corresponding referent. The literature on semantic development indicates that children spontaneously repeat words when parents have previously labeled the objects that were the focus of joint attention (Baldwin & Markman, 1989). This suggests that speech sounds may be easier to learn when they are associated with interesting objects that have been verbally labeled for them by adults.

Edwards (1983) suggested that treatment targets should be relatively easy to remediate so that immediate success may be obtained. To achieve this, treatment targets should include sounds that are sometimes produced correctly or already included in the phonetic inventory even if only used incorrectly relative to the target. An effective strategy that incorporates some of Edward's ideas is to teach all sounds concurrently, both stimulable sounds and nonstimulable sounds. The child would achieve immediate success when stimulable sounds were elicited but also receive remediation on more difficult, nonstimulable sounds at the same time.

In the following case study, a treatment program designed for use with young children is described. It is especially intended for use with children with very limited phonetic inventories and for whom most sounds missing from the inventory are nonstimulable.

CASE STUDY

Participant

Stacy, age 3;4 (years; months) was referred for phonological assessment from a community developmental screening. According to her mother, Stacy's birth was full-term and delivery was by Cesarean section. Her birth weight was 6 lb, 15 oz. Sensorimotor developmental milestones such as sitting, crawling, and walking occurred within normal limits. Stacy's general health was described as good and she had no documented history of hearing problems. Stacy began producing recognizable words about 10 months of age and produced sentences by 2 years of age. Her speech delay was first noted between the ages of 2 and 3 years. Stacy has an older sister, age 5;6, who also was diagnosed with a phonological disorder and a younger brother, age 2;0, with no identified speech problems. Stacy's mother reported that she enjoys playing with other children and participates in group athletic and social activities. According to her mother, Stacy is aware that other people have difficulty understanding her and she is very frustrated when this happens.

Assessment

There was no easily identifiable etiology to account for Stacy's difficulty with the production of speech sounds. She earned a passing score on the *Oral Speech Mechanism Screening Examination—Revised* (St. Louis & Ruscello, 1986). In addition, Stacy passed a hearing screening by responding appropriately to 400-, 1000-, 2000- and 4000-Hz pure tones presented at 20 dB HL (ANSI, 1969).

Two standardized measures, the *Peabody Picture Vocabulary Test—Revised* (PPVT-R), Form L (Dunn & Dunn, 1981) and the *Test of Early Language Development* (TELD) (Hresko, Reid, & Hammill, 1981) were administerd to measure language development. Results of these tests indicated that other aspects of language were developing within normal limits. Stacy's performance on the PPVT-R resulted in a standard score of 98, which placed her in the 45th percentile for her age group. Results of the TELD indicated a standard score of 49, which placed Stacy in the 98th percentile on this measure. Stacy comprehended and followed directions with minimal instruction. A standardized analysis of narrative language was not attempted because of the severely limited intelligibility of Stacy's speech. In addition, her participation in conversation was minimal.

Stacy made 57 errors on the Sounds-in-Words Subtest of the *Goldman–Fristoe Test of Articulation* (Goldman & Fristoe, 1986), which placed her productions in <1 percentile for her age group according to the norms provided. To facilitate a more complete description of Stacy's phonological system, a 104-item subset of the probe developed by Gierut (1985) was also administered. This task provides a sample of major English consonants and includes multiple opportunities to produce each consonant in the prevocalic, intervocalic, and postvocalic positions of single words. Results of the 104-item probe were used to compile a phonetic inventory. To be included in the phonetic inventory, a sound had to be produced at least two times in words with different base morphemes (Stoel-Gammon, 1987). Results of the phonological analysis showed that Stacy's phonetic inventory was limited to production of labial and alveolar stops, nasals, and glides. No productions of fricatives, affricates, or liquids occurred.

Although Stacy produced some stops, nasals, and glides, these sounds were not produced in all word positions. The velar stops, /k/ and /g/, and all fricatives and affricates were realized as [d] in the word-initial position. These sounds were realized as glottal stops or alveolars in the intervocalic position and, with the exception of target [f], were realized as alveolars or omitted in final position. An example of productions of target obstruents is shown in Table 1.

With regard to the sonorants, the labial and alveolar nasals were used correctly and word-final /ŋ/ was produced as [n]. Prevocalic liquids and glides were omitted. Intervocalic liquids were realized as [w], and word-final liquids

Table 1. A Pretreatment Sample of Stacy's Productions of Target Obstruents

Target	Prevocalic position		Intervocalic position		Postvocalic position	
/p/	Peach	[pi]	Soapy	[dopi]	Soap	[dop]
/b/	Bite	[baɪ]	Webby	[ɛbi]	Web	[ɛb]
/t/	Tail	[tʊt]	Biting	[baɪʔɪn]	Bite	[baɪ]
/d/	Dog	[dɑd]	Hiding	[haɪnɪn]	Hide	[daɪd]
/k/	Cage	[deɪd]	Sockie	[dɑtʰi]	Sock	[dɑt]
/g/	Gum	[dʌm]	Froggie	[dɑdi]	Frog	[dɑd]
/f/	Father	[dɑdʊ]	Laughing	[æʔɪn]	Laugh	[æp]
/v/	Vacuum	[dætjum]	Driving	[daɪdɪn]	Drive	[daɪ]
/θ/	Thumb	[dʌm]	Mouthy	[maʊi]	Mouth	[maʊ]
/ð/	These	[did]	Mother	[mʌdʊ]	—	
/s/	Sock	[dɑt]	Dressy	[dɛtʰi]	Dress	[dɛt]
/z/	Zoo	[du]	Nosy	[noʔi]	Nose	[no]
/ʃ/	Shoe	[du]	Pushing	[pʊʔɪn]	Push	[pʊ]
/tʃ/	Chair	[dɛo]	Peachy	[piʔi]	Peach	[pi]
/dʒ/	Juice	[dut]	Cagey	[deɪdi]	Cage	[deɪd]

were produced as vowels or omitted. Glides were produced correctly in the intervocalic position. (See Table 2.)

A stimulability task (Figure 4 of Powell & Miccio, this issue) was administered to assess Stacy's ability to imitate the examiner's production of sounds in isolation and in syllables. Results showed that Stacy was not stimulable for production of any of the sounds missing from her phonetic inventory. Because of Stacy's high level of frustration with speech production, impoverished phonetic inventory, and lack of stimulability for sounds missing from the inventory, she was enrolled in a stimulability treatment program aimed at increasing the number of stimulable sounds in her repertoire.

Table 2. A Pretreatment Sample of Stacy's Productions of Target Sonorants

Target	Prevocalic position		Intervocalic position		Postvocalic position	
/m/	Mouth	[maʊ]	Gummy	[dʌmi]	Gum	[dʌm]
/n/	Nose	[no]	Sunny	[dʌni]	Sun	[dʌn]
/ŋ/	—		—		Driving	[daɪdɪn]
/w/	Web	[ɛb]	Snowing	[noʊwɪn]	—	
/j/	Yellow	[eɪjoʊ]	Yoyo	[jojo]	—	
/h/	Hill	[eɪjoʊ]	Beehive	[bihaɪd]	—	
/l/	Laugh	[æp]	Hilly	[ɪwi]	Hill	[eɪjoʊ]
/r/	Read	[id]	Starry	[dɑwi]	Star	[dɑ]

Treatment Program

The treatment program was designed to increase the size of the phonetic inventory by teaching most major consonants at once. In this study, the liquids /r/ and /l/ were not treated and served as controls for this child. Our major goal was to enhance "stimulability"; therefore, sounds were taught in isolation (i.e., [s::]) or in the case of some sounds, such as stops or glides, in a CV context (i.e., [kʌ]). Each major consonant was associated with a character representing an animal or object. In addition, a characteristic body movement or gesture was associated with each character and its sound (Table 3). Verbal praise was used to reinforce correct speech production and small prizes were given for completing tasks and activities. Stimulability treatment was carried out for 12 sessions. Sessions were approximately 45 min in length and were held twice a week. An outline of a typical treatment session is illustrated in Table 4.

Review of the Characters and Their Sounds. Prior to beginning treatment, we selected an animal or object to associate with each speech sound. A movement or gesture was also associated to the animal or object. This gesture is made while the speech sound is modeled to assist with eliciting the target sound. Color drawings of these characters were made on 5 × 8-in. note cards.

Table 3. Stimulus Characters Used to Elicit Consonant Production[a]

Consonant		Character	Example of an associated gesture
Stops	/p/	Putt-putt pig	Hands move in a skating motion
	/b/	Baby bear	Pantomine rocking a baby
	/t/	Talkie turkey	Nod head from side to side
	/d/	Dirty dog	Dig and frown
	/k/	Coughing cow	Cough with hand at throat
	/g/	Goofy goat	Roll eyes toward ceiling
Fricatives	/f/	Fussy fish	Hand fussily pushes away from body
	/v/	Viney violet	Move arm up as a winding vine
	/θ/	Thinking thumb	Tap thumb on chin
	/s/	Silly snake	Slinkily move finger up arm
	/z/	Zippy zebra	Hastily move finger up arm
	/ʃ/	Shy sheepy	Clutch hands together and look down shyly
Affricates	/tʃ/	Cheeky chick	Sassily tap hand on cheek
	/dʒ/	Giant giraffe	Move eyes upward in stair steps
Nasals	/m/	Munchie mouse	Push lips together and rub tummy
	/n/	Naughty newt	Shake head back and forth negatively
Glides	/w/	Wiggly worm	Shiver
	/j/	Yawning yoyo	Yawn with hand tapping mouth
	/h/	Happy hippo	Laugh and shake shoulders
Liquids	/l/	Lazy lion	Stretch arms lazily
	/r/	Rowdy rooster	Crow with head and shoulders held high

[a] The liquid consonants /r/ and/l/ were not treated in this study.

Table 4. Outline of a Typical "Stimulability" Treatment Session

Task	Approximate time (min)
1. Elicit one-third of stimulability probe	5
2. Review of characters and their sounds	5
3. Stimulability Activity I: Go fish	10
4. Stimulability Activity II: Guess my card	10
5. Stimulability Activity III: Spinner game	10
6. Elicit one-third of generalization probe	5–8

At the beginning of the treatment session, the character cards are shown to the client one by one to focus the child's attention on each character. With the clinician and client's attention jointly focused on the character, the clinician demonstrates the character's sound and the associated movement. The character for /v/, for example, is called Viney Violet. Viney Violet has a long winding stem with a smiling face on the flower at the top of the vine. When the clinician introduces Viney Violet, she pantomimes a climbing vine with her arm as she says [v:]. The consonant sounds listed in Table 3, including those sounds that are in the phonetic inventory, are reviewed in this manner. For purposes of this study, /r/ and /l/ were excluded from treatment and were not associated with characters. As the characters and their associated sounds and gestures are presented through intensive modeling, the child is encouraged but not required to produce the target sounds with the clinician.

Stimulability Activities. Attempts to stimulate sound production are embedded in play-like activities. Developmentally appropriate activities are designed specifically around the target sound characters. The play activities provide the client with the opportunity to imitate the consonants. During these activities the client and clinician take turns so that the clinician is constantly modeling the target sounds as the client attempts to imitate the sounds.

Any number of stimulability activities may be used during the session. The character cards, for example, are used to play familiar games such as Go Fish. The client and clinician each hold a group of cards and ask each other, in turn, for a particular card. Because of the large number of nonstimulable sounds in Stacy's inventory, she often failed to produce the intended sound when making a request. The associated movement or gesture, however, cued the clinician as to which card Stacy was requesting. When Stacy, for example, failed to say [v:] but made a winding vine motion with her arm, the clinician knew the intended sound was /v/. Consequently, the clinician provides appropriate feedback by asking for clarification. The clinician may say, "Let's see, do I have Viney Violet? Viney says [v:]." (Draw's attention to teeth on lower lip.) "Here's Viney Violet: [v:]" (with accompanying gesture). Thus, a multimodality, auditory–visual–tactile, cue is provided. If the child imitates the sound, positive verbal feedback is given. In this way, stimulability tasks are incorporated into games and activities designed to draw attention to speech sounds. To elicit sound production, the child is given an assertive role involving communicative functions of requesting actions and objects or directing attention.

To ensure that the client is successful in producing speech sounds, we include all consonants, even those in the inventory, that are stimulable by definition. Thus, if the child does not successfully imitate a nonstimulable sound, she may next request a character with a stimulable sound. Stacy, for example, did not successfully produce [v:], but she requested Munchie Mouse on her next turn. The nasal /m/ is a stimulable sound, and Stacy successfully requested Munchie Mouse by producing [m:] and rubbing her tummy. In this way, nonstimulable sounds receive intervention while stimulable sounds are reinforced and stabilized in the sound system. When the clinician takes a turn, she redirects attention to the nonstimulable sounds by modeling a nonstimulable sound as she requests a new character card. The child is encouraged to imitate the production. Next, when the child takes a turn and requests a card, the child may request any character, either one that is associated with a stimulable sound or one that is nonstimulable. Because both stimulable and nonstimulable sounds are targeted to expand the phonetic inventory, the child is successful and frustration is kept at a minimum.

Usually two or three activities are used per session to maintain joint attention and interest. Other activities that we have used successfully include placing the cards face down in a box and taking turns picking a card. When the child picks a card, the clinician must guess the name of the character. The child gives a clue by making the associated gesture and attempting the sound. As with the first activity, the clinician identifies the target sound by the associated gesture and either reinforces the correct production or draws attention to the correct production through modeling and phonetic placement cues.

Another popular game is to place the character cards around a gameboard with a spinner in the center. The clinician and client take turns spinning and when the spinner lands on a character, the sounds and their associated gestures are produced. Many of the experiential play activities suggested by Hodson and Paden (1991) are appropriate for use with the sound-character cards. For very young children, the cards can be used in more active play such as a fishing game. For older children, the cards can be incorporated into board games.

As illustrated above, characters are introduced and associated with their sounds and gestures at the beginning of the session. Throughout the session, the clinician and client take turns so that modeling of correct production is an integral part of the activities. In our experience, children who do not respond to conventional treatment approaches such as traditional therapy (Van Riper & Erickson, 1996) or minimal pair treatment (Weiner, 1981) readily attempt to imitate the movements and with little encouragement also try to imitate the sounds. As the client becomes more receptive to the task, instructions to listen and watch the clinician say the sound or phonetic placement cues are occasionally used to shape more precision in imitation. The treatment activities provide a supportive framework that encourages the development of stimulability skills and enhances the awareness of sound properties.

We have employed the above treatment program in small groups. Often, more than one clinician is present and all participate in the activities. Siblings have participated in the stimulability activities as well. Stacy's parents did not directly teach any sounds at home until after the current study was concluded. During follow-up appointments, however, they reported successfully eliciting new sounds at home by using the associated gestures to draw attention to the correct sound during daily activities. This type of activity provides focused attention on all consonant sounds, both those that are stimulable and those that are not, and provides a nonthreatening, pleasant atmosphere in which the child enjoys speech production.

Probes. To determine whether the number of stimulable sounds increased and to evaluate generalization to real words, we incorporated probe activities into our sessions. To avoid losing a young child's attention by devoting too much time to probing, we divided the stimulability probe into three sections and elicited one-third of the probe at the beginning of each session. To illustrate, stimulability for every consonant was probed in isolation and syllables with the vowel [ɪ] at the beginning of one session ([pɪ], [ɪpɪ], [ɪp]) in isolation and in syllables with the vowel [æ] the next session ([pæ], [æpæ], [æp]) and finally in isolation and in the context of [ɑ] the third session ([pɑ], [ɑpɑ], [ɑp]). The following session, probing began again with each consonant probed in syllables with the vowel [ɪ], and so forth. In this way, the entire probe is completed every three sessions for a total of five probes including the baseline probe. In a similar fashion, we divided the 104-item probe, which contains real words targeting each sound in three word positions into three parts. One-third of the probe was elicited at the end of each session. At the end of every third session, a complete probe of the English consonant inventory had been accomplished. No reinforcement was provided during the probes, but the client was rewarded with a small prize at the completion of a probe. Responses were recorded on-line by a graduate student observer trained in phonetic transcription.

Results

Prior to treatment, three baseline sessions were held. At each of these sessions, one-third of the stimulability probe was administered to establish a baseline for stimulability. Stacy then participated in the stimulability treatment program for 12 sessions. During treatment Stacy was taught to produce all sounds except the liquids [r, l]. These two sounds were withheld from treatment to serve as controls because introducing a manner distinction among the obstruents (a Level C distinction) is not expected to result in acquisition of a liquid constant (a Level D distinction). Thus, it was predicted that enhancing stimulability of sounds from Level C would introduce a manner distinction among the obstruents and increase the number of sounds produced within Levels A–C. The total number of successful attempts to produce nonstimulable sounds on the stimulability probe are shown in Figure 1. On Stimulability Probe 1 administered during baseline, no nonstimulable sounds were produced. On each stimulability probe administered during the course of treatment, Stacy gradually increased the number of sounds produced following stimulation. On Probes 2 through 5 administered after treatment had begun, Stacy produced 6, 7, 15, and 26 of the treated sounds in probe items, respectively, that were nonstimulable during baseline. In addition, Stacy produced each of the untreated nonstimulable sounds once in probe items during the course of treatment. The liquid /r/ was produced once during Probe 3 and /l/ was produced once during Probe 5.

Table 5 summarizes which nonstimulable sounds were produced during administration of the stimulability probe. This table demonstrates that although Stacy gradually increased the number of stimulable sounds in her repertoire, the growth in Stacy's stimulability was nonlinear. Sounds that were produced during one probe were not necessarily produced on the next, but reappeared again later. During Probe 2, Stacy was stimulable for production of the four voiceless fricatives and /v/. During Probe 3, however, /θ/ and /ʃ/ were not stimulable, but /ð/ and the affricate /dʒ/ were stimulable. During Probe 4, both affricates and all fricatives except /f/ were stimulated. On the final probe, all fricatives were produced but no affricates. Overall, Stacy became increasingly stimulable for production of sounds missing from her phonetic inventory.

By the end of the final stimulability probe, Stacy was stimulable for production of the fricatives: [f, v, θ, ð, s, z, ʃ]. According to the final 104-item probe, she had added the voiced labiodental fricative [v] and the velar nasal [ŋ] to her phonetic inventory. That is, these two sounds were produced at least two times in words with different base morphemes. In addition, emerging productions (appeared in one word) were observed for [k, dʒ]. Recall that Stacy's pretreatment phonetic inventory contained labial and alveolar stops and nasals and glides, a Level B inventory (Dinnsen et al., 1990). Following direct stimu-

Table 5. Nonstimulable Sounds Produced Successfully during Probes

Stimulability Probe 1 (Baseline): None
Stimulability Probe 2: f, v, θ, s, ʃ
Stimulability Probe 3: f, v, ð, s dʒ, and r (not treated)
Stimulability Probe 4: v, θ, ð, s, z, ʃ, tʃ, dʒ
Stimulability Probe 5: f, v, θ, ð, s, z, ʃ, and l (not treated)

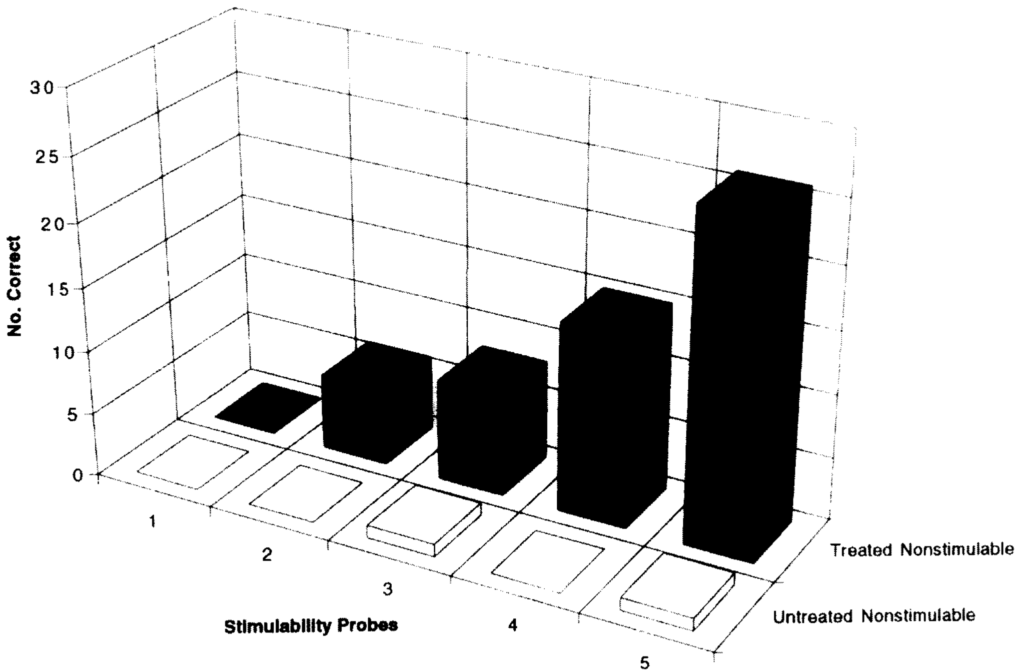

Figure 1. The number of correct productions of untreated nonstimulable sounds (r, l) and treated nonstimulable sounds (k, g, f, v, θ, ð, s, z, ʃ, tʃ, dʒ) on the Stimulability Probe. Stimulability Probe 1 was a baseline probe and Probes 2–5 occurred during treatment.

Phonetic Inventories

Sound Class	Pretreatment	Posttreatment
Stops	pb td □[1]□	pb td (k)[2]□
Fricatives	□□□□□□□	Δ[3]vΔΔΔΔΔ
Affricates	□□	□(dʒ)
Nasals	m n □	m n ŋ
Liquids	□ □	□ □
Glides	w j h	w j h

Notes: [1]□ = Nonstimulable sounds missing from the phonetic inventory; [2] ( ) = Sounds that did not meet requirements for inclusion in the phonetic inventory but which were produced correctly at least once in probe words; [3] Δ = stimulable sounds missing from the phonetic inventory.

Figure 2. Summary of Pre- and Posttreatment Phonetic Inventories and Baseline and Final Stimulability Probes.

lation on all consonants except the liquids, Stacy added a fricative and a velar nasal to her inventory and made marginal productions of a velar stop and an affricate. The addition of these sounds to Stacy's inventory involved the acquisition of a manner distinction among the obstruents and a new place distinction within the established sound classes. These changes reflected an advance to the next more complex inventory, Level C. These data are summarized in Figure 2.

In addition to providing data for determining the phonetic inventory, the 104-item probe was also a source of information for observing other system-wide changes in Stacy's phonology. Prior to treatment, for example, Stacy often reduced the consonant–vowel–consonant (CVC) syllable structure to CV in words ending in fricatives or VC in words beginning with liquids and glides (Tables 1 and 2). At the end of the 12-treatment sessions, Stacy produced more CVC syllables as well as other adult-like syllable structures (Table 6).

During the pretreatment probe, Stacy often produced glottal stops for target obstruents in the intervocalic position. On the other hand, the glottal /h/ was omitted in the prevocalic position. By the end of treatment, the distinction between glottal and oral consonants had stabilized. Selected examples of these changes are shown in Table 6.

Because of the limits of her impoverished phonetic inventory, homonymy contributed to Stacy's unintelligibility prior to treatment. The target words "hill" and "yellow," for example, were both produced as [eɪjoʊ]. Posttreatment, "hill" was produced as [hɪoʊ] and "yellow" as [jɛjoʊ]. Note that although both [h] and [j] were present in the pretreatment phonetic inventory, these sounds were not produced correctly in all word positions. Stimulability treatment may have helped stabilize productions of these sounds and facilitate generalization across word position.

Stacy participated in the stimulability treatment program for a prescribed 12 sessions. At the end of the program, her phonological system was reanalyzed and recommendations were made for continued treatment. Prior to treatment, Stacy was not stimulable for production of any fricatives or affricates.

Table 6. Examples of System-Wide Changes Observed in Stacy's Phonology

Phonological change	Example	Pretreatment	Posttreatment
Syllable structure			
Final consonant	"Push"	[pʊ]	[pʊt]
Intervocalic consonant	"Mouthie"	[maʊi]	[maʊti]
Initial consonant	"Yellow"	[ɛjoʊ]	[jɛjoʊ]
Glottal/oral distinction			
/ʔ/	"Biting"	[baɪʔɪn]	[baɪtɪŋ]
/h/	"Hill"	[eɪoʊ]	[hɪoʊ]

Following stimulability treatment, Stacy was stimulable for production of all fricatives.

The prediction is that the sounds that have become stimulable will not require direct treatment (Miccio, 1995; Powell et al., 1991). Possible targets for intensive treatment would be the velar stops, /k, g/, which were resistant to change during the current treatment period. Also, it may be desirable to teach affricates, which were stimulated inconsistently during the course of treatment. Targeting any of the obstruents should result in the addition of more obstruents to the phonetic inventory, that is, level-internal change (Dinnsen, Chin, & Elbert, 1992). Another possibility would be to teach a liquid, such as /l/. This would introduce a nasal-liquid (Level D) distinction into Stacy's phonetic inventory. These treatment targets would enhance system-wide generalization and introduce further change into Stacy's phonological system.

SUMMARY

The purpose of this article was to demonstrate the usefulness of a treatment program designed to increase the number of stimulable sounds in a child's phonological system. This program was based on the following hypotheses from the treatment research literature:

1. *Facilitate system-wide generalization.* Treatment will be most efficient when sounds that are likely to result in the most generalization are targeted (Gierut, 1989; Powell, 1991). More generalization occurs when unknown aspects of the system are taught (Gierut et al., 1987).
2. *Increase the size of the phonetic inventory.* Teaching sounds with less complex phonetic distinctions results in minimal additions to the phonetic inventory. Teaching sounds with more complex phonetic distinctions, however, results in the addition of more sounds to the phonetic inventory (Tyler & Figurski, 1994).
3. *Teach nonstimulable sounds.* Teaching stimulable sounds results in limited generalization. Teaching nonstimulable sounds results in acquisition of the treated sound(s) as well as untreated stimulable sounds (Powell et al., 1991).

   In addition, this program was also designed to meet the following clinical considerations:

4. *Associate speech sounds with items of interest to the child.* To assist in directing a child's attention to the target sounds, the sounds were associated with animals or objects. To assist in eliciting production, a body movement or gesture was associated with the speech sounds. The character cards and their associated gestures and sounds increase interest in the stimulability tasks and encourage full participation in related activities.

5. *Achieve early success.* To actively involve a child in treatment, both stimulable and nonstimulable sounds are taught concurrently. Early success in producing stimulable sounds encourages attempts to produce the more difficult nonstimulable sounds. In addition, the use of gestural movements to elicit sounds enables the child to successfully communicate requests for actions and objects to the clinician and allows the clinician to provide appropriate feedback for communication attempts.

CONCLUSION

The procedures outlined in this article provide one approach for treating disordered phonological systems. This approach is particularly designed for treating the very small phonetic inventories of young children with few stimulable sounds. Results from the case study illustrate how hypotheses from the research literature can be integrated into our treatment programs. Subsequently, the efficiency of our programs is enhanced.

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