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A Minimal Contrast Treatment for Apraxia of Speech

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Controversy continues to exist over the nature of apraxia of speech, in that researchers are still trying to determine whether sound errors are motorically or linguistically based (i.e., phonetic or phonemic in nature) (Buckingham, 1981; Hardcastle and Edwards, 1992; McNeil and Kent, 1990). Additionally, the possibility exists that across or within individual apraxic speakers, the origins of some sound errors may be mixed, particularly when aphasia and apraxia of speech (AOS) co-occur.

We chose to study a treatment approach that theoretically should be useful in remediating phonetic or phonemic sound errors. This approach combines minimal contrast pairs with traditional therapy techniques such as integral stimulation and articulatory placement cues.

The use of minimal contrast pairs provides a context for subjects to practice articulatory contrasts among sounds. Theoretically, this should facilitate correct sound production when errors stem from a movement or action *programming* disorder. More specifically, repeated productions of contrasts between target and error sounds should provide opportunities for the speaker to modify or refine movement patterns to achieve intended productions. Conversely, the use of minimal contrast pairs provides a pragmatic foundation that may aid in phoneme selection in the case of linguistically based errors. That is, contrasting minimal pairs provides practice in avoiding homonymy, thus adding semantic salience to the process of phoneme selection.

In reviewing past reports of treatment for apraxia of speech (Wambaugh and Doyle, 1994), it was apparent that generalization and maintenance effects of treatment had received relatively little attention. As such, we attempted to extend the AOS treatment literature by including repeated measures of response generalization to untrained exemplars, stimulus generalization to more complex utterances, and maintenance effects of the minimal contrast treatment.

A secondary research question involved examining the relation between daily treatment data and probe data. To thoroughly evaluate this treatment, probes were scheduled following every treatment session. Frequent probing is labor intensive for staff members and may be taxing for some subjects. In a nonresearch environment, such probing would likely be impractical. Therefore, an additional objective of this research was to determine the potential predictive value of treatment data with respect to performance under probe conditions.

METHOD

Subject

The subject was a 52-year-old male with moderate to severe apraxia of speech and nonfluent aphasia. He was 33 months post onset of a left hemisphere CVA and exhibited right hemiparesis. Motor speech examination results revealed no significant abnormalities in muscle tone or strength or any classifiable dysarthrias (Darley, Aronson, and Brown, 1975). The subject was a native English speaker, premorbidly left-handed, had completed over 6 years of graduate school, and was a retired professional. The results of his pretreatment testing are presented in Table 1.

The subject's speech was characterized by trial and error groping (particularly on initial sounds), difficulty initiating speech, numerous perceived sound substitutions, occasional sound distortions, and variability and inconsistency in multisyllabic word productions over repeated trials (i.e., inconsistency of error location and variability of error type on successive productions of multisyllabic words during administration of the Apraxia Battery for Adults [Dabul, 1979]). Sound errors in monosyllabic words tended to be relatively consistent, in that certain sounds were usually produced incorrectly and the errors tended to be nonvariable, in man-

Table 1. Pretreatment Testing Results

Measure	*Score*
Western Aphasia Battery (AQ)	29.3 (100 possible)
Test of Adolescent/Adult Word-Finding (total raw score)	1 (107 possible)
Revised Token Test (overall score)	8.92 (15 possible)
Apraxia Battery for Adults	4 of 5 ratings of *severe*
Mean Length of Utterance (in words) (from 15 minute conversational sample)	2.89

ner, place, and voicing, across repetitions. This consistency of error location and nonvariance of error type was observed in pretesting and in repeated baseline measures. Additionally, the subject displayed awareness of his sound errors and was quite accurate in identifying sound errors, which he often did spontaneously.

Experimental Stimuli

Sixty monosyllabic and bisyllabic words and 30 two-word phrases served as stimuli (Appendix A). The 60 words were comprised of three sets: 20 beginning with /ʃ/, 20 beginning with /r/, and 20 beginning with /sw/. Ten words from each sound set were selected for training and the remaining 10 of each were untrained and used for probing response generalization.

These particular sounds were selected because the subject consistently produced them incorrectly during pretesting. As part of a pretest battery, we assessed consonant production with a 200-word probe, in which consonants were elicited in the initial and final positions of monosyllabic words. This subject usually substituted what was perceived as an [s] for the [ʃ] (e.g., 'seep' for 'sheep'). Conversely, when he didn't omit the [s] from blends, he often produced [ʃ] for [s] (e.g., 'weep' for 'sweep' or 'shweep' for 'sweep'). The subject's productions of [r] were usually either distorted or replaced by a sound perceived as [w].

The 30 phrases consisted of the 10 training words from each sound set preceded by a monosyllabic word. The monosyllabic (nontraining) words were selected so that a syntactically correct, plausible phrase was formed. Target sounds, and other sounds often produced erroneously by the subject (e.g., [k]), were avoided in the nontraining words. Other coarticulatory constraints were not made. The 30 phrases were used for probing stimulus generalization.

Experimental Design

A single-subject multiple-baseline design across behaviors was used to assess the effects of treatment.

Baseline. During baseline, the subject's production of the [ʃ], [r] and [sw] sounds in the 60 words and 30 phrases was assessed. The 60 words were randomized and presented verbally to the subject to elicit imitative productions. Elicitation of the 30 phrases always followed completion of the 60-word probe. During probes, up to two stimulus repetitions by the examiner were allowed as requested by the subject. Self-corrections were not penalized in scoring. All probes were audio recorded using high-quality tapes and equipment. Responses were transcribed on-line, using broad phonetic transcription (Shriberg and Kent, 1982). Audio recordings were used to confirm transcriptions. The percentage of correct productions for each sound group was calculated and baseline probing continued until responses were stable.

Treatment Phase. Treatment consisted of a combination of minimal contrast pairs and traditional therapy techniques, such as integral stimulation and phonetic placement. Minimal contrast pairs were devised for each of the words designated for training (Appendix B). A minimal contrast pair was defined as a pair of morphemes that differed by only one sound segment (Edwards, 1992; Shriberg and Kent, 1982). The target sound and the sound that usually replaced the target sound were used in the pairs (e.g., shine – sign; run – won; swing – wing).

The specific treatment hierarchy is shown in Appendix C. The initial step of the hierarchy consisted of repetition of the minimal contrast pair, followed by a second repetition if the first attempt was incorrect. Written cues, in the form of alphabet letters representing the target sounds, were provided if repetition alone was unsuccessful. Subsequent steps of the hierarchy included integral stimulation, insertion of a silent juncture, and placement instructions as necessary. All individual steps of the hierarchy have been suggested as treatment methods for AOS (LaPointe, 1984; Wertz, Rosenbek, and LaPointe, 1984), and ordering was based on the premise of utilizing the least invasive techniques first (Wertz et al., 1984).

Treatment was applied first to /ʃ/, then to /r/, and finally to /sw/. Each treatment session consisted of a minimum of seven treatment trials, with each trial consisting of randomized presentation of the 10 minimal pairs. Treatment was provided three times per week in the subject's home by a certified speech-language pathologist.

Probes. The 60-word probes, identical to those in baseline, were conducted at the start of the following day's treatment session. The phrase probes were conducted following approximately every four to five sessions.

When the target sound was produced correctly in 80% of the trained words in three consecutive probes (word level), treatment was ended for that sound and initiated with the next sound.

Reliability

Because reliability of transcription of disordered speech is typically rather low (Shriberg and Kent, 1982), we used consensus transcription. A staff member, other than the examiner, independently transcribed every probe using the audio recordings. A third staff member independently transcribed each utterance for which there was a disagreement between the original and second transcription. The consensus of the three transcriptions was then used.

RESULTS

Acquisition, Response Generalization, and Maintenance

Figure 1 depicts the acquisition (filled squares), response generalization (open circles), and maintenance effects of treatment on correct production of [ʃ], [r], and [sw] in words.

These data reveal that correct responses remained relatively low until the initiation of treatment and that acquisition of trained items was rapid across all three sounds. Response generalization to untrained exemplars was also rapid, with these effects being similar to acquisition effects. Response generalization across sounds was negligible. Maintenance effects for [ʃ] and [r] were measured during training of the remaining sound(s). Correct productions of trained and untrained items remained significantly above baseline levels during the maintenance phase.

A follow up probe was conducted 6 weeks following the last treatment session. Correct responses remained at acquisition levels.

Stimulus Generalization

Figure 2 shows the stimulus generalization effects of treatment. The vertical arrows indicate when treatment was initiated with each sound. For all three sounds, correct responses increased above baseline levels following application of treatment.

Correct Responses Per Hierarchy Step

The number of terminal responses at each level of the treatment hierarchy were calculated. That is, we counted the number of times at each step that the subject produced a correct response. Of a total of 1770 items attempted during the course of treatment, the success rate at each level was as follows: (a) Step 1, stimulus repetition = 1207 (68%); (b) Step 2, second attempt of stimulus repetition = 402 (22.7%); (c) Step 3, grapheme paired

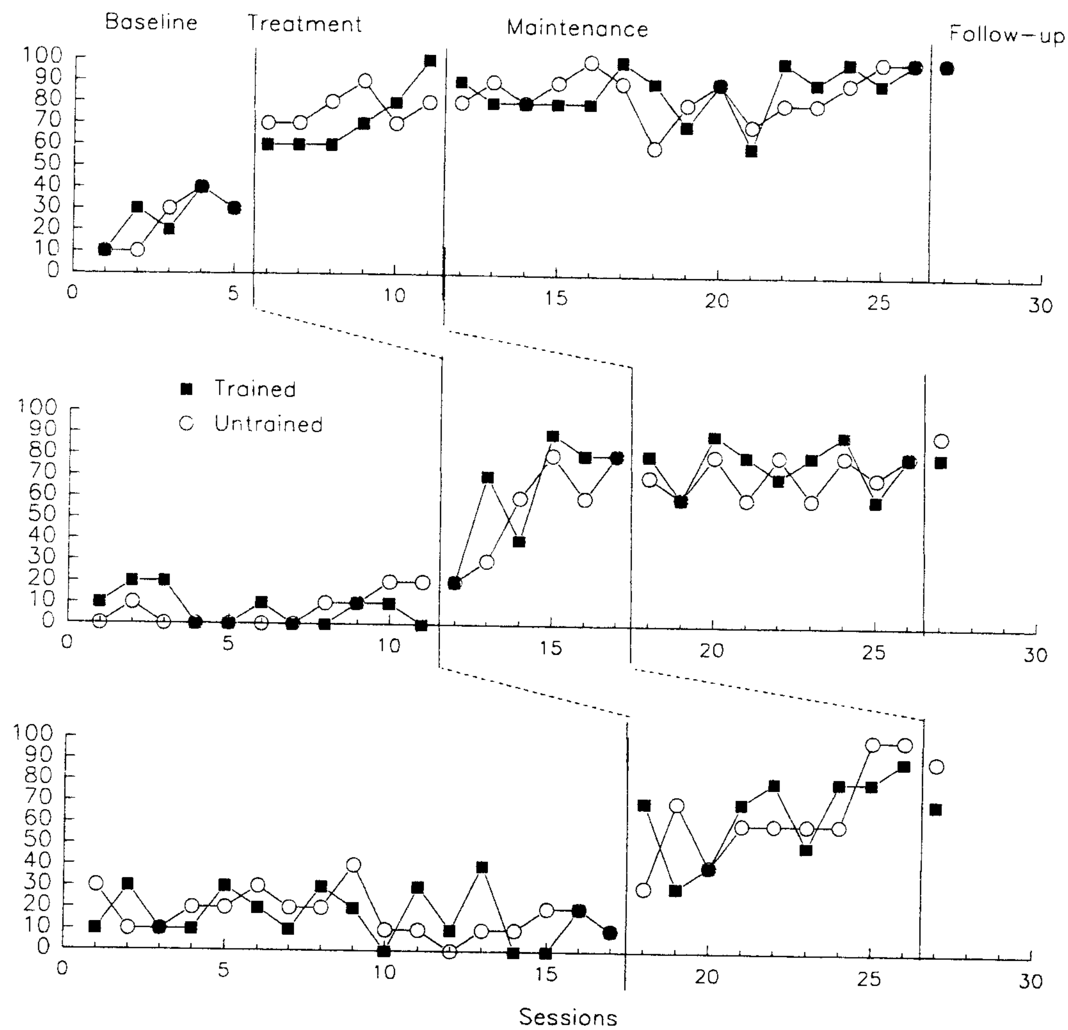

Figure 1. Acquisition, response generalization, and maintenance effects of treatment: percent correct sound productions at word level.

with repetition = 119 (6.7%); (d) Step 4, integral stimulation = 32 (1.8%); (e) Step 5, juncture = 7 (0.4%); (f) placement in isolation = 1 (0.06%); and (g) never correct = 2 (0.1%).

Treatment versus Probe Data

For each treatment session, the percentage of correct responses at Level 1 on the treatment hierarchy (i.e., a correct response after one repetition) was calculated for (a) the session as a whole, and (b) the first two trials for the

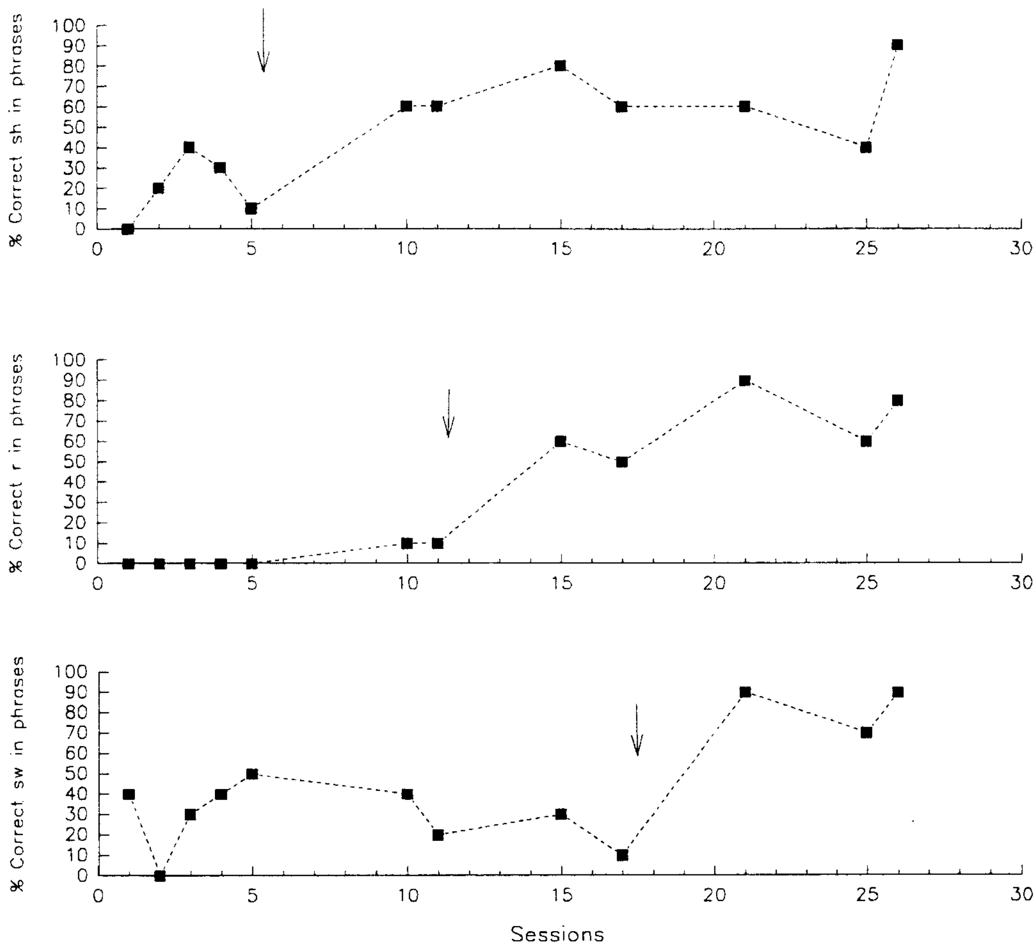

Figure 2. Stimulus generalization effects of treatment: percent correct sound productions at phrase level.

session. Correlations were performed between these values and the corresponding probe session percentage (for treated words) and Pearson r values are presented in Table 2. All of the correlations were relatively low, with the exception of the correlation between the overall session and probe for /r/ words, for which r was .93.

Table 2. Correlations (Pearson r): Probe Data and Treatment Data

Comparison	*Entire Set*	*/sw/ Words*	*/r/ Words*	*/ʃ/ Words*
probe/overall	.51	.66	.93	.01
probe/1st 2 trials	.32	.43	.37	−.30

DISCUSSION

In summary, this treatment approach was found to be effective in promoting correct productions of targeted sounds in trained words as well as untrained words for this subject. These generalization effects were stronger than we would have predicted on the basis of existing literature (Raymer and Thompson, 1991).

In contrast, generalization to untrained sounds was negligible. We were particularly interested in observing [sw] productions during [ʃ] training, since this subject often substituted the fricatives [s] and [ʃ] for each other. We hypothesized that training [ʃ] in minimal pairs with [s] would result in improved productions of [sw]. Unfortunately, this was not the case. Possibly, the context of [s] in a cluster was too difficult to expect generalization from practice of a singleton, or perhaps the [w] in the cluster had too strong of a coarticulatory influence in terms of lip rounding. We did observe during training that the subject tended to overgeneralize the trained sound to the contrasting sound of the minimal pair. For example, initially during treatment, the subject would frequently produce 'sin' – 'sin' for the minimal pair 'shin' – 'sin' or 'seep' – 'seep' for 'sheep' – 'seep'. However, after he became proficient in producing [ʃ], he began to err in the opposite direction and displayed difficulty with the [s] (e.g., 'shin' – 'shin' for 'shin' – 'sin'). After several sessions of such responding, he stopped overgeneralizing. It is possible that the [ʃ] training actually reinforced the incorrect [sw] productions through overgeneralization. When [sw] was trained we anticipated that there might be overgeneralization of the [s] to the previously trained [ʃ]. However, this was not the case.

The treatment also resulted in stimulus generalization to targeted sounds produced in phrases. We were unable to measure stimulus generalization to contexts that did not require repetition, such as confrontation naming or oral reading, because of this subject's deficits in word finding and reading. Measurement of stimulus generalization effects of treatment in additional contexts should be a focus of future research. Also, more general measures of verbal skills, which are not sound specific, may provide additional information about the effectiveness of treatment.

As indicated earlier, conducting probes often seems to take an inordinate amount of time and effort, for both the subject and the researchers. Unfortunately , this subject's treatment session performance did not accurately predict his probe performance. Several factors may account for the relatively low correlations between treatment and probe data: (a) the temporal relations between collection of the data sets (i.e., collection of the two data sets always occurred on different days, with the probe data being gathered 2 to 3 days following the corresponding treatment session); (b) the subject's knowledge regarding the evaluative nature of probes; (c) differences in task difficulty; and perhaps several other unknown variables. As such, until we have a better understanding of the effects of such variables on apraxic subjects' responses to treatment, it appears necessary to probe more frequently than would be desirable in most clinical settings.

Our research design did not permit us to experimentally evaluate the effects of individual steps in our treatment hierarchy. Nevertheless, we can observe that, for this subject, verbal repetition comprised the bulk of his treatment and the remainder of the hierarchy was seldom needed. In light of this subject's overgeneralizations, the minimal contrast pairs appear to be an important component of this package. Replications with additional subjects are required to allow generalizations regarding the effectiveness of this treatment approach.

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APPENDIX A: EXPERIMENTAL STIMULI

Trained Words			Untrained Words		
/ʃ/	/r/	/sw/	/ʃ/	/r/	/sw/
shine	rip	swing	shin	ripe	swan
sheep	run	sweet	ship	wren	sweat
shoot	rig	sweater	sheet	rag	swallow
she	ride	swill	shake	red	swell
shack	room	swat	shun	ram	swap
shed	raise	swore	shoes	rise	swear
shave	rock	switch	shell	Rick	swatch
shore	real	swish	shop	rail	Swiss
shy	right	sweep	shag	rate	swoop
shock	rave	swag	shame	rove	swig

Phrases

/ʃ/	/r/	/sw/
nice shine	we rip	the swing
her sheep	they run	not sweet
we shoot	that rig	her sweater
for she	the ride	the swill
the shack	her room	please swat
that shed	his rock	he swore
I shave	please raise	that switch
the shore	not real	we sweep
so shy	not right	they swish
they shock	the rave	her swag

APPENDIX B: MINIMAL CONTRAST PAIRS

/ʃ/	/r/	/sw/
shine = sign	rip = whip	swing = wing
sheep = seep	run = won	sweet = wheat
shoot = suit	rig = wig	sweater = wetter
she = see	ride = wide	swill = will
shack = sack	room = womb	swat = what
shed = said	raise = ways	swore = wore
shave = save	rock = wok	switch = witch
shore = sore	real = wheel	swish = wish
shy = sigh	right = white	sweep = weep
shock = sock	rave = wave	swag = wag

APPENDIX C: TREATMENT

Step 1—Minimal pair repetition: The trainer produced the minimal pair and requested the subject to repeat the pair (e.g., "say shock . . . sock"). If the initial sound in both words was correct, feedback was provided and the next pair was presented. If either of the initial sounds was incorrect, trainer went to next step.

Step 2—Minimal pair repetition again: Examiner provided feedback and modeled the minimal pair again and asked subject to repeat. If both sounds correct, next pair was presented. If incorrect, went to next step.

Step 3—Minimal pair repetition with visual cue: Examiner provided feedback and showed subject printed graphemes of target sounds. Examiner produced word pairs again and asked subject to repeat while focusing on graphemes. If both sounds correct, next pair presented.

Step 4—Integral stimulation, single word level: If both initial sounds of the minimal pair words were incorrect or only the target sound was incorrect, the examiner focused only on the target word at this point. However, if only the initial sound of the paired (nontarget) word was incorrect, the examiner provided positive feedback about the target word and then focused on the nontarget word at this point. (e.g., "Watch me, listen to me, and say it with me.") If the sound being focused upon was correct, then the next pair was presented.

Step 5—Silent juncture: The examiner modeled the word with a silent juncture and asked the subject to repeat using the juncture (e.g., "say the word like this, sh. . .ock"). If correct, next pair presented.

Step 6—Articulatory placement in isolation: The examiner provided specific articulatory placement instructions, modeled sound, and asked subject to produce sound in isolation. If correct or incorrect, next pair presented.

Modifications to minimal pair presentation: If the subject was successful at Step 1 for 80%–100% of the minimal pairs in one trial, then the hierarchy was used exactly as above. However, if the subject was successful at Step 1 for 50%–80% of the minimal pairs, then single target words (not pairs) were used in every other trial to reduce frustration by providing more success. And if the subject was successful at Step 1 for less than 50% of the pairs, two single word trials were used for every paired word trial.