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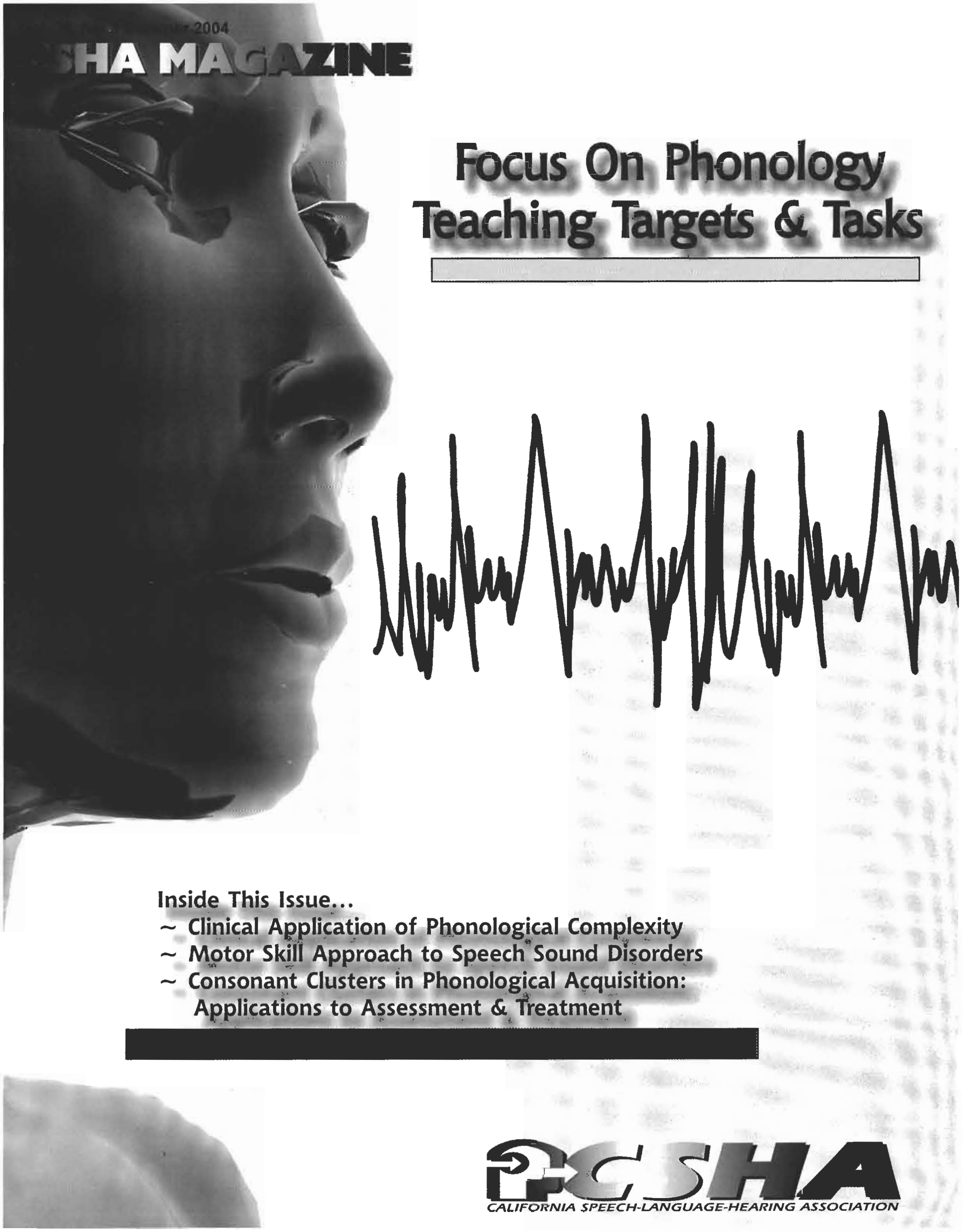

Focus On Phonology
Teaching Targets & Tasks

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Clinical Application of Phonological Complexity

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Abstract

The goal of this paper is to illustrate the selection of target sounds for treatment based on phonological complexity. Complexity based on developmental and linguistic factors is considered and applied to a clinical case of a child with a functional phonological disorder. Step-by-step procedures in target selection are described for direct extension to the clinical setting.

The clinical treatment of children with functional phonological disorders has undergone a radical reconceptualization. Over the past two decades, a wealth of evidence has accumulated to show that treatment of complex phonological targets leads to the greatest generalization learning. *Generalization learning*, as it has been defined, refers to change in treated and untreated sounds, with change in untreated sounds being further differentiated as within or across class gains. *Within class gains* refer to improvements in untreated sounds that share the same manner as the treated sound. For example, if the treated sound is a fricative, and a child learns other untreated fricatives, then this would be called within class change. *Across class gains* refer to improvements in untreated sounds that are unrelated to the treated sound. Continuing the example, if treatment of a fricative also leads to the learning of other untreated nasals and stops, this would be called across class change. These different types of generalization learning are relevant because they determine the efficacy of phonological treatments. In this regard, the ultimate clinical goal is to induce the greatest change in a child's sound system following the least treatment. Those treatments that achieve widespread change in treated and untreated sounds within and across class are notably the most efficacious. Importantly, it is precisely this type of system-wide improvement that comes about as a direct result of treatment based on phonological complexity.

Thus far, phonological complexity has been explored from a number of different perspectives, including but not limited to developmental, linguistic, phonetic, treatment and lexical considerations. From this work, it has been possible to identify a range of complex treatment targets to enhance children's generalization learning. Listings of complex targets are readily available in published chapters and overviews about the complexity method (Gierut, 1998, 2000, 2004, in press). Nonetheless, the real challenge for clinicians is the actual implementation of phonological complexity. Given a host of known complex targets, how is an optimal target selected for treatment of a given child? The goal of this paper is to address this question by illustrating one approach to the decision making process for a clinical case. Beginning with a brief review, we will specifically consider developmental and linguistic variables in the selection of a complex target for treatment for a child with a functional phonological disorder.

Developmental and Linguistic Complexity

Conventional approaches to phonological treatment often recommend that treatment focus on errored sounds that a child produces with some degree of accuracy (Hodson & Edwards, 1997). Consistent with this view, treatment of stimulable sounds has also been advocated, along with earlier acquired sounds following from developmental normative sequences. These recommendations, however, result in only limited generalization specific to the treated sound and perhaps also within class change in untreated sounds (Rvachew & Nowak, 2001). In contrast, a complexity approach promotes greater system wide change when treatment focuses on errored sounds that have a 0% baseline accuracy, are nonstimulable, and also developmentally later acquired (Gierut, Morrisette, Hughes, & Rowland, 1996). Complex targets trigger improvements in production of treated and untreated sounds within and across class for the most efficacious intervention. In this clinical application then, we will only consider sounds for treatment that meet three criteria: 0% accuracy across all word positions, nonstimulability, and late normative acquisition.

Adding to these variables, we will further focus target sound selection by considering specific linguistic factors that are associated with sound co-occurrences. One well-documented fact of language is that certain sounds and sound classes co-occur. That is, if a language has sound class X, it will also have sound class Y, but not vice versa. These co-occurrence relationships are called *implicational language laws*. They have strong clinical relevance because treatment of sound class X predictably enhances the learnability of sound class Y. In other words, treatment of X predicts generalization to Y; consequently, it may be unnecessary to teach the latter. A number of implicational laws have been reported in the clinical literature, and for our purposes, we will apply four of these to our clinical case. Specific co-occurrences are (1) liquids predict nasals in a child's sound system, (2) fricatives predict stops, (3) affricates predict fricatives, and (4) voiced stops, fricatives or affricates (also called *obstruents*) predict voiceless stops, fricatives or affricates. Following from this list and the predicted patterns of generalization, the more complex targets are the liquids, fricatives, affricates and voiced obstruents, respectively. With three developmental and four linguistic factors of complexity, we turn now to their clinical application in a case study.

Table 1

Goldman-Fristoe Test of Articulation results for Child MD.

	I	M	F	Stim
p	b		Ø	YES
m			Ø	YES
n			Ø	YES
w				
h				
b				
g				
k		t	Ø	YES
f	b	p	Ø	NO
d				
ŋ			n	NO
j				
t	d	d	Ø	YES
ʃ	ts	t	Ø	NO
tʃ	ts	t	Ø	NO
l		w	Ø	YES
r	w	w	Ø	NO
dʒ	dz	dz	Ø	YES
θ	d	t	Ø	NO
v	b	p	Ø	NO
s	d	t	Ø	NO
z	d	d	Ø	YES
ð	d	d		YES

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Complexity in Target Sound Selection

The child of study is a boy, MD, age 4 years, 8 months of age. MD was diagnosed with a functional phonological disorder, evidencing no other apparent deficits in hearing, intelligence, motor, social, receptive or expressive language skills. MD's performance on the Goldman-Fristoe Test of Articulation (Goldman & Fristoe, 1986) is shown in Table 1. Stimulability of errored sounds is also reported. The task at hand is to use these data, coupled with developmental and linguistic factors of complexity, to select an optimal treatment target to facilitate system wide phonological gains.

Developmental factors. We begin first by identifying only those targets that are produced with 0% accuracy. These would be sounds in error in each of the sampled positions on the GFTA. Beginning with /p/ and working sound-by-sound through the score sheet, we can see, for example, that MD had inconsistent errors of /p m n k/; therefore, these would be eliminated from the pool of potential sounds for treatment based on complexity. The sound /f/, however, is produced in error in each of three word positions; /f/ then is reserved as a possible treatment target. Continuing down the score sheet, we see that /t ʃ tʃ/ are in error in all three contexts, whereas /ŋ l/ are not. Consequently, /ŋ l/ are removed as targets, but /t ʃ tʃ/ remain for consideration. By evaluating the rest of the data in this same way, the end result is that /f t ʃ tʃ r dʒ θ v s z ð/ meet the criterion of 0% production accuracy. These sounds are the possible candidates for treatment based on complexity. They will also be critical later with respect to measurement of change.

To narrow the set size of possible treatment targets, stimulability status is considered, such that we will select from among those sounds in the pool that are nonstimulable. From data in the right-most column of the GFTA, it can be seen that /t dʒ z ð/ are all stimulable, whereas /f ʃ tʃ r θ v s/ are not. The latter nonstimulable sounds remain in the possible set of complex targets for treatment.

Developmental normative scales are consulted next. Following the Nebraska-Iowa normative data reported by Smit and colleagues (Smit, Hand, Freilinger, Bernthal, & Bird, 1990), we consider the expected ages of acquisition by boys for the possible treatment targets. These are age 3;6 for /f/, 7 for /ʃ tʃ/, 8 for /r θ/, 5;6 for /v/, and 7 to 9 for /s/. Any sound that is mastered by age 4 years, 8 months is eliminated, as this corresponds to MD's chronological age. Based on MD's chronological age relative to the normative data, we remove /f/ from the pool of targets because it is an earlier acquired sound. Thus, /ʃ tʃ r θ v s/ remain for further evaluation with respect to complexity and implicational laws.

Linguistic factors. Table 2 displays the candidates for treatment by their place, voice and manner. This facilitates our examination of the predicting (and predicted) sound classes based on implicational laws. A first law states that liquids predict nasals. Notice that the liquid /r/ is included as a possible treatment target; however, the relevant question is whether treatment of /r/ will enhance its co-occurring class, namely, the nasals. If nasals were 100% accurate, treatment of /r/ could have no impact on the co-occurring class. While nasals are not among the possible targets for treatment, GFTA data do show that MD had inaccurate inconsistent production of /ŋ/. Consequently, treatment of /r/ does offer a prediction of generalization learning, and therefore, /r/ remains as a possible target for treatment.

Another relevant law states that fricatives predict gains in stops. In the case of MD, we are entertaining fricatives /v θ s ʃ/ as potential targets, but as before, we must ask whether treatment of fricatives could lead to gains in the co-occurring stop class. MD's data show errors in production of /p t k/; hence, fricatives stay in the pool of potential targets for treatment.

A third law states that affricates predict fricatives. Notice here that the affricate /tʃ/ is a possible treatment target, and so are the fricatives /v θ s ʃ/. Because treatment of affricates predicts acquisition of fricatives, we can eliminate /v θ s ʃ/ from further consideration. Acquisition of these is expected to follow directly from treatment of the affricate. The pool of complex targets is now considerably smaller, including only /tʃ r/.

A fourth law predicts that voiced obstruents enhance acquisition of voiceless obstruents. The only obstruent remaining in the candidate set is the voiceless affricate /tʃ/. Voiceless sounds are the less complex element of the law, and these do not predict bidirectional generalization to voiced sounds. Consequently, /tʃ/ is removed as a potential target for treatment. This then leaves /r/ as the optimal target for treatment for MD as based on the specific factors of developmental and linguistic complexity.

Extensions of Complexity

Through a step-by-step decision making process, it has been possible to systematically identify an optimal target for treatment based on complexity for this clinical case study. But, sound selection is just one aspect of a child's overall treatment program, and there are a number of other decisions that clinicians routinely make in the process. We close the discussion with some related questions about the clinical applications of complexity.

Measurement of change. Measurement of change is central to the complexity approach. In order to determine if treatment indeed promotes system-wide gains, it is necessary to probe for increased accuracy of all sounds in the initial pool of potential treatment targets. Returning to our clinical case, in selection of /r/ as a phonologically complex target, we anticipate that MD will show production gains in the treated sound and other untreated targets within and across class. For MD, probes would minimally include a sampling of /f t ʃ tʃ r dʒ θ v s z ð/. These are all of the sounds that were identified as having 0% baseline accuracy and given this, they provide the most detail about the ultimate extent of generalization learning. Probe data should be obtained periodically throughout the treatment program as intermediate goals are achieved.

Teaching procedures. Having identified an optimal target and probe sample, how should teaching proceed? Thus far, the efficacy literature has shown that different methods of teaching are essentially equivocal in that no one teaching method is better than another (Gierut, 1998). In the absence of definitive data, it is only safe to say that basic principles of phonological learning may be employed including, for example, the use of modeling, corrective feedback, successive approximation and branching.

Other factors of complexity. In the case of MD, seven factors of phonological complexity were used in sound selection. The selection process proceeded in a fixed order, beginning with 0% accuracy and ending with the implicational law about obstruent voicing. This tack was used for illustration purposes, and it is only one of the ways that decision making might proceed within

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Table 2

Pool of target sounds for treatment based on phonological complexity as shown in bold. Sounds in shadow are in reference to the inventory of target English.

Nasals	m			n		ŋ	
Stops	p b			t d		k g	
Fricatives		f **v**	**θ** ð	**s** z	ʃ ʒ		
Affricates					**tʃ** dʒ		
Liquids				l	**r**		
Glides	w				j		h

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a complexity approach. Another clinician with another case may go about target sound selection starting, for example, with phonetic or lexical aspects of complexity as these may better address the child's needs. Research on treatment efficacy still has a ways to go before it will be possible to determine the additive effects, precedence relationships, or upper limits on phonological complexity, thereby fine-tuning the sound selection process. Nonetheless, this represents an exciting time in our profession because the clinical application of complexity holds much promise in advancing the efficacy of phonological treatment.

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