Minimal Pair Approaches to Phonological Remediation

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ABSTRACT

This article considers linguistic approaches to phonological remediation that emphasize the role of the phoneme in language. We discuss the structure and function of the phoneme by outlining procedures for determining contrastive properties of sound systems through evaluation of minimal word pairs. We then illustrate how these may be applied to a case study of a child with phonological delay. The relative effectiveness of treatment approaches that facilitate phonemic acquisition by contrasting pairs of sounds in minimal pairs is described. A hierarchy of minimal pair treatment efficacy emerges, as based on the number of new sounds, the number of featural differences, and the type of featural differences being introduced. These variables are further applied to the case study, yielding a range of possible treatment recommendations that are predicted to vary in their effectiveness.

KEYWORDS: Phoneme, minimal pair, phonological remediation

Learning Outcomes: As a result of this activity, the reader will be able to (1) analyze and recognize the contrastive function of phonemes in a phonological system, (2) develop minimal pair treatment programs that aim to introduce phonemic contrasts in a child's phonological system, and (3) discriminate between different types of minimal pair treatment programs and their relative effectiveness.

Models of clinical treatment for children with functional phonological delays have been based on three general theoretical frameworks. Some models are founded on development given that the population of concern involves children. Other models have their basis in cognition given our need to understand how learning takes place in the course of intervention. Still other approaches are grounded in linguistics because the problem at hand involves the phonological system. In this article, we explore the linguistic bases of phonological

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intervention with a specific focus on the phoneme. We ask three questions: What are the structure and function of phonemes in language generally? How are phonemes assessed in children's sound systems? And, how might treatment be designed to best facilitate phonemic acquisition?

WHAT IS A PHONEME?

For the linguist interested in the study of phonology, a primary aim is to establish the inventory of sounds and how these function in a given language. For the speech-language pathologist, a key to establishing treatment goals is to assess the sounds of a child's phonological system. As with the linguist studying a newly discovered language or reanalyzing a well-known one, our clinical aim in analyzing a developing phonological system is to determine which sounds are used as phonemes by a child and which are used as allophones. To evaluate this requires a firm understanding of just what a *phoneme* is. A phoneme reflects a certain "ideal" concept of a sound, according to the perceptions of the speaker, even though that phoneme might actually be produced phonetically in a variety of ways. Take the phoneme /t/, for example. As speakers of the English language, we all share a similar concept of /t/. This is reflected in our spelling as well as our perceptions about the sounds in our language and in other languages. When we hear words such as "tie," "star," "butter," and "button," we, as English speakers, recognize that all of these words have the sound /t/ in common. This is the case despite the fact that the relevant sounds in these words are actually quite different from one another in production. Whereas "tie" is pronounced with an aspirated [tʰ] as [tʰɑɪ], "star" is pronounced with an unaspirated [t] as [stɑr]. "Butter" is pronounced with a flap in American English as [bʌɾɚ], and "button" is produced with a glottal stop as [bʌʔn̩]. Nevertheless, speakers of the English language assume that all four of these phones [tʰ t ɾ ʔ] belong to one and the same category—the phoneme /t/. These four phonetic variants then are *allophones* of the phoneme /t/.

By definition, phonemes are abstract, mental concepts of sounds that reflect a speaker's internal or mental knowledge about the language he or she speaks, and they function to mark distinctions in meaning. Phonemic distinctions are made most apparent in minimal pairs. A *minimal pair* is a set of words that differ by a single phoneme, whereby that difference is enough to signal a change in meaning. For instance, the words "map" [mæp] and "mat" [mæt] form a minimal pair in English. These two words are identical in terms of the first consonant and the vowel. They differ only by the last consonant—[p] versus [t]—and this difference signals a change in meaning ("map" versus "mat"). English speakers would agree that "map" and "mat" are two very different words with two very different meanings. The "map"–"mat" example illustrates how minimal pairs reveal phonemic contrasts in final position, but contrasts also occur in other contexts, including word-initial position, such as "map" [mæp]-"cap" [kæp], as well as word-medial positions, such as "fashion" [fæʃən]-"fasten" [fæsən]. Cluster contexts, both initial and final, can also be revealing of contrasts, as with "spy" [spɑɪ]-"sky" [skɑɪ] or "cats" [kæts]–"caps" [kæps]. Vowels too contrast within minimal pairs, as with "map" [mæp]–"mop" [mɑp] and "cap" [kæp]—"keep" [kip]. Finally, *near minimal pairs* are found via cluster-singleton comparisons, such as "play" [pleɪ]–"pay" [peɪ], or vowel- versus consonant-final comparisons, such as "boat" [boʊt]–"bow" [boʊ].

In comparison with these examples of phonemes revealed by minimal pairs, we consider another possible pair in English, [mæp] and [mæp̚]. These two forms are identical with respect to the first consonant and the vowel as with the "map"–"mat" example. Similarly, they also differ only by the final sound: released [p] versus unreleased [p̚]. However, most important, this phonetic difference does not signal a change in meaning because the two words mean exactly the same thing, "map." With no difference in meaning, [mæp] and [mæp̚] do not form a minimal pair. Consequently, [p] and [p̚] are not contrastive, nor do they function as

phonemes in English; instead, they are allophones (phonetic variants) of the phoneme /p/.

Phonemes are typically viewed as phonetic reflexes of a complex of smaller sized units known as distinctive features. Consequently, it is not the phonemes per se that are the contrastive elements of a language; rather, it is their featural makeup. The features that contrast serve to create an "opposition" between phonemes of a particular language.[1,2] Phonemes may contrast with one another along one or more of a number of specific feature dimensions. In formalized linguistic frameworks, these featural contrasts are described in terms of distinctive features as described in, for example, *The Sound Pattern of English*.[3] These can be interpreted in perhaps more familiar terminology associated with place, manner, and voice for the present purpose, as illustrated for English phonemes in Table 1.

Place of articulation features differentiate labial, coronal, and dorsal contrasts, which are relevant to the phonemic distinctions among /p t k/ and /b d ɡ/ in, for example, "pea," "tea," and "key" or "by," "dye," and "guy," respectively. Manner of articulation features differentiate [continuant] contrasts, which are relevant to distinctions between stops, fricatives, and affricates. This feature would distinguish, for example, /p/ from /f/ in "pea"–"fee," or /ʃ/ from /tʃ/ in "shoe"–"chew." Manner features also differentiate [nasal] and [lateral] contrasts, which relate to nasals, liquids, and glides. These would distinguish /n/ from /l/ in "no"–"low," or /l/ from /r/ in "lake"–"rake," respectively. Voice features differentiate cognate pairs, such as /p b/ in "pie"–"by" as well as /t d/, /f v/, /s z/, and /tʃ dʒ/. Together, the features associated with place, manner, and voice are called *nonmajor class* distinctions. These are differentiated from other *major class* properties.

The major class features serve to differentiate among the main groupings of sounds in language, namely consonants versus vowels, glides versus consonants, and obstruents (stops, fricatives, and affricates) versus sonorants (nasals, liquids, glides, vowels). The featural distinctions that mark these respective contrasts are [syllabic], [consonantal], and [sonorant]. For example, the contrast between /b/ and /m/ in the pair "by"–"my" illustrates that a major class distinction between obstruents and sonorants ([sonorant]) occurs in English. Similarly, the contrast between /m/ and /w/ in "my"–"why" shows that a major class distinction between consonants and glides ([consonantal]) also occurs in English.

Based on their featural characteristics, then, phonemes may contrast with one another either *minimally* or *maximally*. A minimal contrast is defined by a single or just a few feature differences among phonemes. The difference between "pie"–"by" involves a minimal contrast in voice, whereas the differences between "tea"–"key" or "toe"–"so" involve minimal contrasts in place and manner, respectively. By comparison, a maximal contrast means that a phonemic difference cuts across many featural dimensions of place, manner, and voice. The phonemes /b/ and /s/ in the pair "be"–"see" differ along all three dimensions with a place contrast differentiating labial from coronal, a manner contrast differentiating stop from fricative, and a voice contrast differentiating voiced from voiceless.

Table 1 English Phonemes

		Labial			**Coronal**			**Dorsal**	
		Bilabial	**Labio dental**	**Inter dental**	**Alveolar**	**Palato alveolar**	**Palatal**	**Velar**	**Glotta**
Obstruent	Stop	p b			t d			k g	
	Fricative		f v	θð	s z	ʃ ʒ			
	Affricate					tʃ dʒ			
Sonorant	Nasal	m			n			ŋ	
	Liquid				l		r		
	Glide	w					j		h

Thus, we have seen that the features that make up phonemes may vary in terms of the type and the number of contrastive differences. Significantly, phonemic distinctions that involve a maximal number of feature differences and that involve major class features are generally the most salient contrasts of languages of the world.[4,5] These also tend to emerge first in language acquisition, and the more specific distinctions are elaborated later.[1] Therefore, more fine-grained phonemic contrasts are typically indicative of increased featural complexity in the phonological system.

ASSESSING PHONEMES IN A CHILD'S SYSTEM

In assessing the phonemes of a child's phonological system, the speech-language pathologist, like the linguist, must evaluate both their structure (what sounds occur?) and their function (is their role contrastive?). To do this requires examining the child's phonemic system independently of the target phonology and then comparing how the child's use of phonemes may diverge from what is expected. In this way, independent and relational analyses are employed.[6–8]

To illustrate the assessment process, we consider the clinical case of a child we will call "Joseph." This boy (aged 4;1) was diagnosed with a functional phonological delay. His speech samples were drawn from a large-scale longitudinal study of children with phonological delay of unknown origin.[9–12] Joseph presented with normal hearing, intelligence, oral-motor functioning, and receptive and expressive language skills as determined by formal testing procedures. His phonetic inventory is shown in Table 2, as derived from a two-time occurrence of sounds, independent of context and accuracy, from a 306-item single-word speech sample.[13] Only the phones that Joseph actually produced are shown (whether or not target appropriate); all other (target) sounds were not produced or used by the child. Hence, these sounds were excluded from the phonetic repertoire. As can be seen, Joseph produced stops, nasals, and glides of target English but lacked most fricatives (excepting [f v]) and all affricates and liquids.

The data in Table 3 provide examples of Joseph's productions that can be used to identify which of these phones actually functioned as phonemes in his system. (These data are provided in alphabetic order by column according to English spelling of the target word.) Recall that phonemes are revealed by minimal pairs; therefore, it is necessary to identify minimal pairs in Joseph's sample. One example from Table 3 is the child's production of the words "drive" [gɑɪ] and "bite" [bɑɪ]. The productions were identical with the exception of the sounds [g] and [b], and they differed semantically. These two words then formed a minimal pair, which means that /g/ and /b/ functioned as phonemes in Joseph's sound system. Moreover, the featural contrast involved a

Table 2 Phonetic/Phonemic Inventory of Joseph (Male, Aged 4;1)*

		Labial			Coronal			Dorsal	
		Bilabial	Labio dental	Inter dental	Alveolar	Palato alveolar	Palatal	Velar	Glottal
Obstruent	Stop	/p/ /b/			/t/ /d/			/k/ /g/	/ʔ/
	Fricative		f v						
	Affricate								
Sonorant	Nasal	/m/			/n/			/ŋ/	
	Liquid								
	Glide	/w/					/j/		/h/

*All sounds are included in phonetic inventory, while sounds in phonemic inventory are presented in slashes.

Table 3 Data from Joseph

Target	Production	Target	Production
[baɪ]	"bite"	[pi]	"pig"
[bʌ]	"bus"	[kin]	"queen"
[ti]	"cheese"	[ho]	"robe"
[kʌp]	"cup"	[taʊp]	"sharp"
[kʌʔ]	"cut"	[to]	"soap"
[do]	"dress"	[tuʔ]	"soup"
[gaɪ]	"drive"	[tʌni]	"sunny"
[paɪ]	"five"	[tʌmi]	"thumby"
[gɪp]	"gift"	[to]	"toes"
[du]	"juice"	[tuʔ]	"tooth"
[kɪp]	"kids"	[bæn]	"van"
[kiŋ]	"king"	[waʊp]	"yard"
[mʌ]	"mud"	[ju]	"you"

minimal and nonmajor class difference between dorsal and labial places of articulation. Notice, however, that this minimal pair in Joseph's system was not target appropriate. This notwithstanding, the phonemes /g/ and /b/ that Joseph used to signal meaning differences are also used as phonemes in the English language, as with "guy"–"buy". Thus, although the minimal pair evidence was incorrect relative to English, the phonemic status of /g/ and /b/ was the same in Joseph's system and English. Thus, there was a match between the phonemic repertoires of the target language and Joseph's phonology.

The same was not true of some of Joseph's other productions. The words "toes" and "soap," for example, were both produced as [to]. Similarly, "soup" and "tooth" were both produced as [tuʔ]. These pairs of words clearly have different meanings in English, but they did not form a minimal pair in Joseph's system because they were produced in exactly the same way. This means that the target English phonemes /s/ and /t/ did not function the same way in Joseph's system. There was a mismatch between the phonemes of English and the phonemes of Joseph's phonology. Joseph collapsed the intended phonemic contrast, with all target /s/ and target /t/ words being produced identically as [t]. In fact, [s] never occurred in any of Joseph's productions as was noted in his phonetic inventory (Table 2). This collapse of the contrast resulted in *homonymy*, whereby words with different meanings were pronounced in the same way.

Continuing in the fashion of identifying minimal pairs and homonymy in the speech sample, Joseph's phonemic inventory was thereby constructed. The sounds that functioned as phonemes for the child are presented between slashes in Table 2. From this table, it is apparent that there are a number of gaps in the child's phonemic repertoire relative to target English; in particular, fricatives, affricates, and liquids did not function to signal meaning differences in this child's use of language. These sound classes then would be potential targets for clinical treatment, with the goal being to introduce the phonemic contrasts of English that are absent from the child's system.

STRUCTURING PHONEMIC INTERVENTION: CONTRAST TREATMENT

Minimal pair treatment is one model of intervention aimed at introducing new phonemic distinctions in language.[14–24] This model is an outgrowth of its original applications to second language learning,[25] and its underlying assumptions follow directly from linguistic constructs as outlined earlier. In essence, minimal pair treatment teaches featural contrasts through the use of pairs of words that differ by a single phoneme. The featural differences between the phonemes are the focus of treatment. The premise is that, once a featural difference is introduced, that same difference will be applied by a child to other relevant phonemic pairs. For example, the phonemes /k/–/t/ differ in terms of place, dorsal versus coronal. If the place distinction is learned in treatment of /k/–/t/ pairs, this same dorsal-coronal contrast should be carried over to other dorsal-coronal pairs such as /g/–/d/ and /ŋ/–/n/. The clinical advantage then is that generalization to untreated phonemes is expected to occur. Minimal pair treatment can be set up in a variety of ways that affect the extent of generalization for children with phonological delays.

Conventional Minimal Pair Treatment

The conventional minimal pair model of treatment targets a phonemic contrast by pairing a sound that is produced in error by a child with its corresponding substitute. Presumably, the substitute will be a sound that differs minimally from the target phoneme.[22–24] In Joseph's case, a clinician might select /s/ and contrast it with /t/. Recall that the phoneme /s/ is absent from Joseph's phonemic repertoire and [t] is the corresponding substitute. As noted, these two sounds differ minimally in manner of articulation (Table 1). With acquisition of the fricative-stop contrast between /s/ and /t/, a clinician might expect that other related fricative-stop distinctions would also emerge in Joseph's sound system.

The conventional minimal pair model makes two further assumptions that are best exemplified by their application. Continuing the example, the two phonemes /s/–/t/ would be presented in a treatment session as pairs of words, perhaps represented pictorially and displayed in an array. In a game format, Joseph would be instructed to name one of the pictures, with the clinician guessing which picture was named. For example, using the minimal pair "sail"–"tail," it is likely that Joseph would produce both words as [teɪl] given the collapse of contrast between /s/ and /t/. Consequently, the clinician would be likely to point to the picture of "tail" even when Joseph had intended the alternate "sail." Typically, under the conventional format, explicit instructions about the place, manner, or voice of /s/ production would not be provided. The clinician would only provide feedback about the miscommunication, showing confusions about which one of the pair to choose. To correct the ambiguity, Joseph must learn to modify his homophonous productions, and this may take different forms. For example, Joseph might produce another fricative in place of /s/, perhaps [f] or [ʃ]. Because Joseph's productions would no longer result in homonymy, and the target fricative-stop contrast was being preserved, the clinician would reward a successful communication by selecting the intended "sail." In this way, outputs that eliminate ambiguity associated with homonymy would be deemed "correct." Homonymy presumably motivates phonemic change. Thus, the foundation of the conventional minimal pair approach is to (1) modify groups of sounds that are produced in error in a patterned way, (2) highlight featural contrasts rather than accurate sound production, and (3) emphasize sound use for communicative purposes.[26]

Two spin-offs of the conventional minimal pair model have been proposed, both of which focus on relationships between target phonemes and substitutes. Under a *multiple opposition* approach,[27,28] sound pairs are selected based on every one of a child's substitutes for a target sound.[29] For a child who exhibits a great deal of variability, for example, producing target /s/ as [t d θ l], four sets of minimal pairs would be introduced in treatment: /s/–/t/, /s/–/d/, /s/–/θ/, and /s/–/l/.

Under an alternate *metaphon* approach, one target-substitute sound pair is selected for treatment, but the way it is taught includes a metalinguistic component.[30–32] Metaphon emphasizes real-world opposites (e.g., long-short, back-front) and relates them to oppositions of the sound system in language. The concept of long-short might be associated with a fricative-stop error or back-front with a dorsal-coronal substitution pattern.

The conventional minimal pair treatment model has been reported as clinically effective, but a number of questions have been raised that have prompted further research in this area. The conventional approach has been viewed as a conceptual form of intervention, but some have speculated about whether instructions about place, manner, or voice of production might also be necessary.[33] This may be of relevance when children use nonambient sounds as substitutes, such as the velar fricative [x] for /ʃ/, or when distortions are produced, such as [s̪] or [ɬ] for /s/.[34] In cases such as these, it would not be appropriate to pair the target with its nonambient or distorted substitute because these are neither phonetic nor phonemic in English. Moreover, a child's outputs would not result in the homonymy that is

apparently needed to promote change. In addition to these concerns, some have considered whether homonymy is indeed relevant to change in development.[20,33,35–39] If homonymy does trigger change, then one might ask why fully developed languages allow homophonous forms without breakdowns in communication (e.g., English "to"–"two"–"too," "buy"–"bye"–"by").[40] With these questions in mind, we turn to two studies that have examined some of the assumptions of the conventional model.

Saben and Ingham[33] evaluated the effects of minimal pair treatment with and without imitation and articulatory placement cues. Results indicated that some children may require these steps before improvements in target sound production are observed. This suggests that addressing the function of the sounds in communication, as recommended by conventional minimal pair approaches, may not be the single most important variable that is crucial to treatment effectiveness. Gierut[20,37–39] further examined the role of homonymy in promoting sound change in a series of studies that evaluated the relative effects of two different treatment conditions on children's sound systems. In one treatment condition, a target sound was paired with its substitute for expected homophony in production. In another treatment condition, two target sounds, both of which were excluded from the child's inventory, were paired with each other. Here, the children's outputs were expected to be nonhomonymous. Results indicated that the nonhomonymous condition resulted in greater improvements in the children's sound systems. Although the homonymous condition did lead to generalization, this occurred to a lesser extent. These findings lend further support to the hypothesis that homonymy may not be a necessary component in phonological change.

Minimal Pair Variants

In a related vein, researchers have also considered the substance of the contrast that is presented in minimal pair treatment. This has resulted in several new minimal pair models that manipulate the number of new phonemes introduced in treatment, the nature of the comparison sound, and the number and type of featural differences among phonemes being treated. Consider that the conventional model introduces only one target phoneme, and this is paired with the substitute. It is also possible to teach one target phoneme but to pair it with another known (and correct) phoneme unrelated to the substitute. Further, two target phonemes, both absent from a child's inventory, may be paired with each other. The effectiveness of these alternate pairings was evaluated relative to the conventional format and to each other. Results indicated that contrasting one new phoneme with an unrelated known phoneme induced greater generalization than the conventional target-substitute format.[38,39] In turn, targeting two new phonemes led to greater generalization than treatment of a new phoneme contrasted with another known sound.

The number of feature differences in a contrast has also been examined. Recall that the conventional model recommends treating phonemes that differ minimally, thus allowing the emergence and generalization of a specific featural contrast. But it is also possible to manipulate maximal feature differences in minimal pairs by differentiating along the dimensions of place, manner, and voice as well as major class properties.[36] Targeting maximal differences does not necessarily constrain which features will emerge or generalize but leaves this to a child's own phonological problem solving.[41] Research that has tested minimal versus maximal feature differences in treatment has found in fact that targeting a maximally opposed sound pair resulted in greater generalization than did a minimally opposed pair.[20,37]

Finally, the nature of the feature differences presented in minimal pairs has been experimentally evaluated. The distinction is between treatment of salient featural contrasts associated with major class versus more fine-grained distinctions associated with nonmajor class properties of place, manner, or voice.[20,36] These studies determined that sound pairs differing by major class features result in greater generalization than sound pairs that differ only

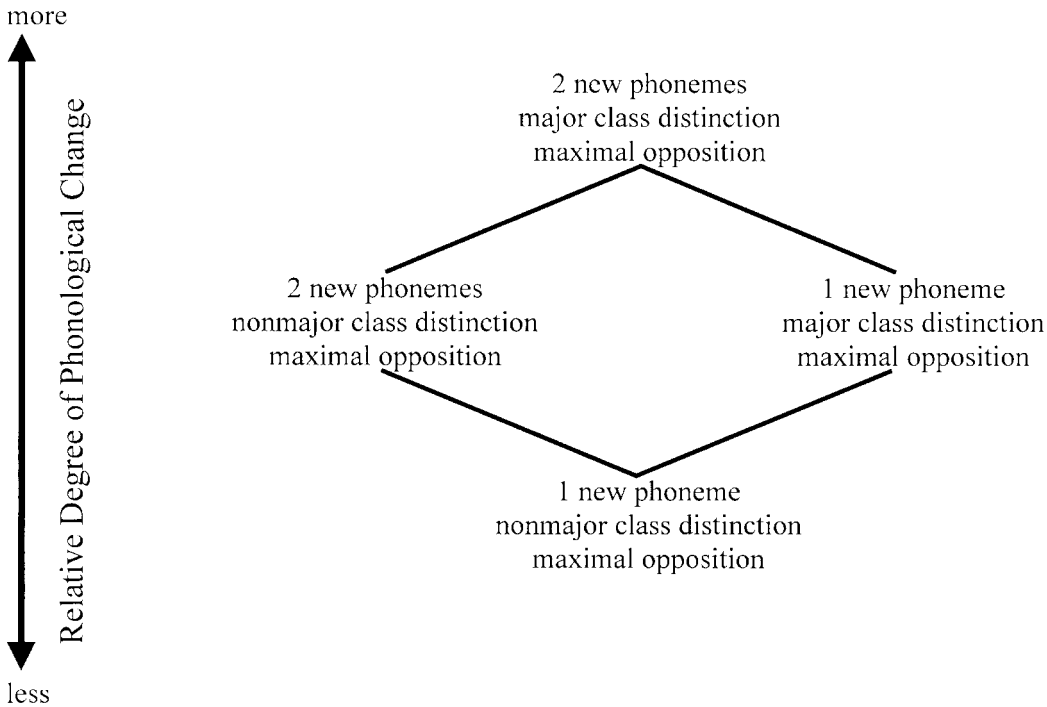

Figure 1 Hierarchy of maximally opposed minimal pair treatment alternatives and their relative effectiveness in inducing phonological change in delayed sound systems. Adapted from Gierut.[20]

by nonmajor class. This includes comparisons of obstruents versus sonorants and consonants versus glides.

Taken together, research on minimal pair variants[20,37,38] suggests that the most effective conditions of contrast include pairing two new phonemes that differ maximally and by major class features. Although this may be the optimal structure of minimal pairs, there is a hierarchy of effectiveness as depicted in Figure 1. Notice in particular that there is a trade-off between number of new sounds (two versus one) and type of distinctions (major versus nonmajor). That is, two new sounds contrasting a nonmajor place, manner, or voice distinction are likely to be just as effective as teaching a major class distinction by contrasting one new phoneme paired with a known sound. Also, although this hierarchy describes minimal pairs only involving maximal feature differences, the same relative relationships hold true for minimal feature differences.[37,38] Finally, it is also important to keep in mind that although one minimal pair structure has emerged from this research as most effective, there may be certain instances when a clinician selects a treatment pair that is expected to be less than optimal. These may be cases in which the goal is to elaborate upon properties of a child's sound system that are already in place, as in building the fricative repertoire if at least one fricative is already being used phonemically. Here, it may be appropriate to select one new fricative and to pair it with another phoneme to create nonmajor and maximal distinctions.

To illustrate the application of these potential minimal pair variants, we return again to the case of Joseph. For continuity with the prior discussion, we selected /s/ as one target phoneme to be treated. Following Figure 1 and with reference to Joseph's inventory in Table 2, it is possible to make predictions about which phonemes might induce the greatest generalization using minimal pairs in treatment. Table 4 shows several possible contrasts that may be targeted in treatment for Joseph, assuming that the target sound was /s/. These include homonymous versus nonhomonymous, one versus two new

Table 4 Possible Contrastive Sound Pairs for Joseph: Treatment Target /s/

Target Sound Pair	No. of New Sounds?	Homonymous Pair?	Place, Manner, Voice Differences?	Major Class Distinction?
/s/–/t/	1	Yes	M	No
/s/–/f/	1	No	P	No
/s/–/b/	1	No	PMV	No
/s/–/w/	1	No	PMV	Yes
/s/–/θ/	2	No	P	No
/s/–/dʒ/	2	No	PMV	No
/s/–/r/	2	No	PMV	Yes

sounds, maximal versus minimal opposition, and major versus nonmajor class distinction.

Predictably, the greatest generalization will occur if /s/ is paired with another new phoneme involving maximal and major class feature differences. Given the phonemic inventory of this child, we see that phonemes /f v θ ð s z ʃ ʒ tʃ dʒ l r/ are all excluded. Thus, for the most effective treatment involving the structure of two new sounds with maximal and major class feature differences, /s/–/r/ would be a likely target sound pair. These two sounds differ from one another in terms of place, manner, and voice features and by the major class feature [sonorant] (Table 1). For somewhat less effective treatment for Joseph, we might consider pairing two new sounds that are maximally opposed with nonmajor class distinctions. In this case, /s/–/dʒ/ would be one appropriate target pair. Although these sounds contrast along only nonmajor class features, they differ maximally across the three domains of place, manner, and voice, as can be observed from Table 1. An equally effective contrast would pair one new sound with one known sound that is maximally opposed by a major class feature, such as /s/–/w/. These two sounds differ by two major class features ([sonorant, consonantal]) and furthermore differ along all three dimensions of place, manner, and voice. The relatively least effective treatment would involve pairing one new sound and one known sound that differ maximally and by nonmajor class features, such as /s/-/b/. Contrasts other than those listed in Table 4 may be selected on the basis of the same considerations, including the pairs that target a sound other than /s/. In all cases, the potential contrasts for treatment are identified in reference to Joseph's phonemic inventory in Table 2.

Throughout this article we have discussed minimal pair treatment programs that focus on *production*. However, some minimal pair approaches have implemented a perceptual component prior to or perhaps even in lieu of production treatment.[15,42,43] Such research has established that perceptual training involving minimal pairs can facilitate production accuracy. Furthermore, the effectiveness of perceptually based minimal pair treatment is based on the pairing of sounds that differ by a maximal number of distinctive features, including the major class features.[42,43] Thus, productively based and perceptually based minimal pair approaches converge in their format.

In conclusion, minimal pair treatment models, no matter their form, maintain a common goal that derives from constructs of linguistic theory; that is, to teach the phonemic distinctions of language. Phonemic contrasts, however, constitute just one of the formal properties of a phonological system. Hierarchical elements of phonology include such structures as the word itself, stress, and syllables, in addition to phonemes and features. Models of intervention that target these complementary structures have likewise benefited from linguistic theory.[44–52] This underscores the integral influence of linguistics on intervention for children with functional phonological delays.

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