30 A Cognitive Approach to Clinical Phonology

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30.1 Introduction

The task of the clinical phonologist is to evaluate the speech production abilities of children and adults with speech difficulties, aiding the speech-language pathologist in assessing the need for treatment, and helping monitor progress during and after treatment. This task has remained and probably will remain fairly constant over the years; the tools that are used to perform it, however, have changed and will continue to change over time. Not surprisingly, the practice of clinical phonology is greatly influenced by current trends in general phonological theory, which in turn alter according to which linguistic theory is presently popular.

30.1.1 Linguistic theory in developmental phonology

The history of the field of developmental phonology provides an excellent example of how general linguistic theory is extended to work in related disciplines. Roman Jakobson, in his seminal paper on phonological acquisition and phonological disorder associated with aphasia (Jakobson, 1968), applied principles of early structural linguistics, which was popular at the time, to arrive at his conclusions regarding the universal order of acquisition of phonemic contrasts. Later, with the rise of generative approaches to phonology after the publication of Chomsky and Halle's *Sound Pattern of English* (1968), scholars of child language began to describe phonological acquisition in terms of abstract underlying representations and obligatory realization rules. Stampe's *natural phonology* (Stampe, 1969; see also Miccio and Scarpino, chapter 25 in this volume) led to the discussion of innate phonological processes in children's speech, while the advent of optimality theory (Prince & Smolensky, 1993; see also Dinnsen & Gierut, chapter 27 in this volume) has generated an extensive literature about the ranking and reranking of constraints during the developmental process. Many of these individual approaches to the study of phonology

have left permanent traces in the clinical world. For example, children are often diagnosed as disordered on the basis of Jakobson-like ideas of a universal order and a universal timetable of acquisition of individual speech sounds. Meanwhile, the most enduring influence of Stampe's natural phonology is probably the role that phonological processes continue to play in the description of the systematic errors that occur both in typical development and in children with phonological disorders.

This chapter will introduce a relatively new approach to phonology, *cognitive phonology*, and will discuss how this theory may prove useful for the work and thinking of clinical phonologists. Although the innovative ideas of cognitive phonology are certainly relevant to all clinical populations, discussion in this chapter regarding clinical applications will focus primarily on developmental phonology and the remediation of phonological disorders in young children.

30.1.2 *The terms: Cognitive vs. usage-based*

The term *cognitive phonology* should be taken as a general descriptor for the phonological theory that will be described here rather than as a hard and fast label. In fact, the same general approach has probably gone by a variety of different names in the existing literature and the term 'cognitive phonology' has certainly been used for a variety of different approaches that may have important differences. Our preferred terminology is *usage-based phonology*; this is the term used by Bybee in her 2001 book *Phonology and Language Use*, which provides an in-depth discussion of her theory. The theory discussed in this chapter is grounded in Bybee's concept of usage-based phonology.

30.2 Usage-Based Linguistics

The term 'usage-based' was first introduced in 1987 by Ronald Langacker in his book *Foundations of Cognitive Grammar*. In this book he described a usage-based model of language as one in which "Substantial importance is given to the actual use of the linguistic system and a speaker's knowledge of the full range of linguistic conventions" (Langacker, 1987, p. 494). This approach stands in stark contrast to the generative position which distinguishes competence from performance and takes competence to be representative of the true nature of the linguistic system. Most notably, a usage-based framework for linguistic study assumes an intimate relationship between language use and language structure, with structure seen as both a generator and a product of language use. With specific reference to phonology, a usage-based account will emphasize the role that language use plays in shaping a linguistic sound system (Bybee, 2001), while a usage-based approach to phonological acquisition will highlight the important role of input and use in the instantiation and ongoing modification of the child's phonological system.

Several key characteristics of a usage-based approach to linguistics in general, and phonology in particular, are outlined below (see also Kemmer & Barlow, 2000). For readers familiar with more traditional phonological theory, the notable differences between usage-based phonology and other rule- or constraint-based theories will be evident. For readers with a background in clinical phonology, the fundamentals of usage-based phonology may seem quite obvious and very compatible with their clinical experiences.

30.2.1 *Language use creates structure*

As the term implies, a usage-based approach to linguistics assumes a *close relationship between linguistic structure and instances of language use*. Specifically, the linguistic system itself is a product of a speaker's experience with specific instances of language production and comprehension. This approach de-emphasizes the abstract/concrete dichotomy that is such an important feature of generative accounts of phonology. While generative theory assumes stripped-down, abstract phonological representations, a usage-based approach denies the existence of abstract structure in the absence of a direct link to a specific instance of use; linguistic structure itself is dynamic, and is constantly being changed by use. This emphasis on individual instances of language use allows word-specific phonetic detail to be part of our linguistic system. This viewpoint is compatible with an exemplar model of lexical storage. In general terms, exemplar theory holds that all instances of a particular token (a word, for example) are stored whole and relationships develop among the different tokens according to phonetic similarities and patterns of use (Johnson, 1997; Pierrehumbert, 2001). Certain categories may emerge from these relationships, centering on the best or most frequent exemplars, but these categories are flexible and are subject to modification depending on the nature of the input. Exemplar models allow for associations at numerous levels of representation, from the phrase to the phoneme (or its equivalent) and even the feature. While exemplar theory itself is not intrinsic to usage-based approaches to linguistics, the emphasis on experience, on use creating structure, and on structure as a dynamic property influenced by instances of production and comprehension is certainly consistent with usage-based linguistics.

30.2.2 *Frequency*

A second, and extremely important, aspect of usage-based theories is the *emphasis on the role of frequency in the shaping of linguistic structure*. The role of frequency in language processing is a well-established phenomenon. In perception, for example, more frequent forms are accessed more quickly and more accurately. In production, a number of different effects have been noted. For example, Bybee (2000) describes a significant effect of token frequency on the deletion of final /t/ and /d/ in American English. Two thousand tokens of words with final t/d targets were analyzed. The results of the transcription-based analysis

indicate that word frequency is a significant factor affecting the deletion of final t/d; final /t/ and /d/ were deleted significantly more often in the high-frequency forms (see also Gregory, Raymond, Bell, Fosler-Lussier, & Jurafsky, 1999). The explanation for this effect is that sound changes affect words 'opportunistically' each time they are produced. Therefore, frequent words are exposed to the sound change more often, and the lexical representation adjusts so that the changed form becomes a more central member of the category.

30.2.2.1 Token frequency

The frequency effect discussed in the above section represents the influence of token frequency. As defined by Bybee, token frequency is "the frequency of occurrence of a unit, usually a word, in running text" (2001, p. 10). Token frequency can be counted for a theoretically infinite number of linguistic structures, including phrases, words, syllables, phoneme combinations, and individual phonemes. The first phonological effect of token frequency is illustrated in the above description of t/d deletion. Words and constructions that are more frequent are more likely to undergo processes of phonetic reduction; therefore, sound change that is motivated by articulatory forces will affect high-frequency forms first. Another effect of token frequency is that it renders high-frequency forms less susceptible to change associated with grammatically based analogical forces. This phenomenon is best explained with reference to the notion of lexical strength, as a product of frequency. A stored item accrues lexical strength by repeated use: each instance of use has the effect of strengthening the representation of an item, making it more accessible (Bybee, 1985). If a form is readily accessible, it is less likely to undergo change influenced by similarities to other recurring patterns. For example, there are relatively few irregular past-tense verbs in English. Many of those individual forms, however, are highly frequent. Because the high-frequency past tense *went* is easily accessed, it is unlikely to become regularized to *goed*. On the other hand, less frequent irregular past-tense forms such as *wept* or *crept* are much more likely to undergo the process of regularization, becoming *weeped* or *creeped*.

30.2.2.2 Type frequency

Token frequency represents only one way to count frequency. The other way to count yields type frequency, which plays a major role in the determination of productivity of patterns of linguistic use. Type frequency describes the relative frequency of a pattern or schema. That is, the greater the number of items that a specific pattern applies to, the higher its type frequency. To return to the English past-tense example, the regular past-tense morpheme has a very high type frequency since most verbs are regular and therefore fit the pattern of the English regular past tense. Therefore, when a new verb or a nonce form is presented, it is this most frequent inflectional pattern that will usually apply in the formation of the past tense of the novel form. In phonology, type frequency may be defined in a number of different ways. For example, all

words that share a common onset may be thought of as conforming to a specific schema. In developmental phonology, children in early stages of word learning often seem to come upon a preferred production pattern that is then extended to other words that share some acoustic or articulatory property with the pattern (Stoel-Gammon & Cooper, 1984; Vihman, 1992). Vihman called these preferred production patterns *vocal motor schemes*; these vocal motor schemes allow children to make rapid progress in the development of a productive lexicon, creating many near-homophones in the early vocabulary. These words would all conform to the same basic phonological pattern, which would be considered to have a high type frequency.

30.2.3 *Emergence*

Another important feature of most usage-based accounts is the notion that *linguistic representation is emergent*, not stored as a fixed entity. This approach rejects the rule/list dichotomy advocated by Pinker (1991, 1999), among others, that the language system consists of a static list of lexical forms and a separate store of rules that operate on those lexical forms. Instead, linguistic units are seen as cognitive routines that emerge by generalizing over existing forms and extracting patterns of similarity, or 'schemas', to use Langacker's term, of different levels of generality (Langacker, 2000). Since the patterns that emerge are entirely dependent on instances of language use, there are no *a priori* limitations on the levels of representation that may exist; schemas may describe grammatical constructions, words, syllables, phonemes, features, or gestures. In the process of phonological acquisition, this notion of emergence would not assume the existence of phoneme-like categories. Instead, phonological knowledge is a gradient property that is extracted from similarity relationships between individual items in the lexicon.

The basic idea behind emergence, as described by Bybee (2001), is that complex structure can be created through the repeated application of simple properties; something much more complex than the sum of the individual instances can emerge. An important implication of this is that complex linguistic structure can be created; it need not be the product of innate mental programs.

In a usage-based model, linguistic categories emerge from the organized lexical storage in which associations form between phonetically and semantically related items. Some associations are stronger than others, depending on the degree of similarity, how often the items are accessed together, and the lexical strength of individual items. Both token and type frequency will influence the relative strength of individual representations as well as the strength of the associations between lexical items. In Bybee's (2001) view, storage is redundant in that multimorphemic words, including regularly inflected words, may be stored holistically, and even multiple representations of the same word may exist. The similarity associations between forms give rise to the generalizations or schemas, allowing morphological and phonological structure to emerge.

30.2.4 Use of data

Another characteristic of a usage-based theory of language, which distinguishes it from more traditional approaches, is the *importance of using data in theory construction*. As opposed to the acceptability judgments that constituted the majority of the evidence for generative accounts, usage-based theorists assume that the object of study is the language that people actually produce and understand. Thus, theory based on the study of large spoken and written corpora, as well as some experimental work, is making its way into general linguistic theory. This change in approach to theory building parallels the change that occurred in the study of developmental phonology, when researchers began to look closely at the speech of more and more children and discovered that the theories based on a few limited observations or anecdotal reports were not adequate. Furthermore, within a usage-based framework, attention should be paid not only to those forms that are consistent with the general patterns, but also to exceptions and marginal cases. From a clinical perspective, this is an extremely important aspect of usage-based phonology; the variability that is often observed in certain clinical populations may prove to be a valuable source of information about the nature of phonological representations and associations between those forms.

30.2.5 Language as a general cognitive function

Usage-based accounts relate language learning to other types of learning that exploit the same necessary mental capacities such as memory, motor control, categorization, and inference making, to name a few (Bybee, 2001). This is the basis of Langacker's use of the term 'cognitive grammar'; grammar is derived from general cognitive capacities, thereby minimizing the role of innate structures (Langacker, 2000). Bybee (2001) adds to this the notion of grammar as procedural knowledge; through practice and repetition, aspects of language become quite automatic and are executed in much the same way as other types of highly practiced motor routines. Phonology, as a highly redundant system of repetition of a limited number of patterns, is part of the articulatory and perceptual procedure for producing and understanding language.

30.2.6 Importance of context

Finally, usage-based models of linguistics emphasize the *importance of context in the acquisition and operation of the linguistic system*. Instances of language use include specifics about the context of the usage event, including non-linguistic and social factors. Context-dependent use of language in the early stages of acquisition is a well-known phenomenon, the ability to de-contextualize language in both comprehension and production involves a process of generalizing over multiple instances of use of similar patterns, thereby extracting schemas that can be used in novel situations. Linguistic structure, however, is

never entirely de-contextualized, even in fully mature systems; abstractions are always linked to individual instances of use.

The preceding discussion of the aspects of a usage-based model of linguistics may be succinctly summarized using Langacker's three descriptive terms for cognitive linguistics: maximalist, non-reductive, and bottom-up (Langacker, 2000). In other words, storage and representation is thought to be highly redundant, concrete as opposed to abstract, and phonological generalizations arise out of specific instances of use.

30.3 Clinical Applications of Cognitive Phonology

Thinking about language use and the importance of context is certainly not a strange concept for most practicing clinicians. When the language system is impaired, the role of context and functional use is almost always considered in planning intervention. For example, augmentative devices are often arranged so that the most frequently used words and phrases are most easily accessed. Similarly, treatment may include specific work on words, phrases, and even entire dialogues that are most useful in the daily communicative interactions of the individual client. This focus on context and patterns of use, however, is usually not extended to the treatment of children or adults with phonological disorders. Thus, a usage-based approach to clinical phonology will differ considerably from a more traditional approach in that great importance will be placed on the role of individual patterns of use in both the evaluation and treatment of phonological disorders.

30.3.1 The object of study

Perhaps the biggest difference in terms of clinical thinking, however, will stem from the idea that phonological competence in a usage-based approach is not described merely in terms of the mastery of individual features, contrasts, or sounds, as is typical of most clinical practice. From a usage-based perspective, phonology does not exist in isolation, but only in relation to stored lexical items. Furthermore, the underlying representations for these items are thought to be concrete, as opposed to abstract, and productions would not be described in terms of rules or processes that change a correct underlying form into the erred production. Thus, analysis would consist of looking at existing networks of lexical items that are either sufficient or insufficient for the emergence of individual phonological patterns and units. Therefore, clinical phonological analysis will go well beyond the phonemic inventory and the description of existing phonological processes, and will include analysis of the individual lexical items that are present in the child's vocabulary and the specific patterns of use of those items.

30.3.2 Phonology and the lexicon

The idea of an important link between phonology and the lexicon is certainly not a new one in the field of clinical phonology and phonological development. In the 1970s, child phonologists began to acknowledge an important relationship between phonological and lexical development. Ferguson and Farwell (1975), for example, highlighted the importance of the 'lexical parameter' in phonological acquisition. In this view, phonological development is not just a matter of change in the system (rules), but may take place on a word-by-word basis, reflecting the individual experiences and preferences of the child. This position was extremely influential in the field of developmental phonology for many years. However, recent attempts to integrate developmental phonology with mainstream phonological theory, most notably Optimality Theory, have again minimized the role of lexical-phonological interactions in development. Usage-based phonology, with its emphasis on language use and emergence of phonological structure, may provide an opportunity to merge developmental phonology with mainstream phonology without minimizing the importance of the relationship between phonology and the lexicon (Pierrehumbert, 2003).

30.3.3 Predictions of usage-based phonology

Usage-based phonology makes testable predictions regarding patterns of phonological development that one would expect to see. Specifically, the role of frequency (both token and type frequency) would be predicted to have an observable influence in typical development, and may be exploited in planning treatment for individuals with delayed or disordered development.

Unfortunately, the data regarding the role of frequency in the diffusion of developmental sound change in typical development are limited. A few studies, however, suggest that accurate productions may emerge first in high-frequency words (Leonard & Ritterman, 1971; Tyler & Edwards, 1993; but see Velten, 1943) and in high-frequency/-probability sound sequences (Beckman & Edwards, 2000; Zamuner, Gerken, & Hammond, 2004). Other predictions include differential roles for production vs. perception frequency; for example, a word that is heard infrequently, but produced often, may be less accurate than words that are heard more frequently. Usage-based phonology also makes specific predictions regarding the role of frequency in the process of sound change. For example, high-frequency words are more susceptible to change caused by articulatory forces (as seen in the example of final t/d deletion discussed above). Low-frequency words, however, are more susceptible to change by analogy; that is, low-frequency items are more likely to conform to a high type frequency pattern. The goal of the clinical phonologist is to cause change in the disordered sound system of an individual; thus, understanding and employing these principles of usage-based phonology may prove very beneficial in promoting sound change. While a more complete understanding

of the role of token frequency and type frequency in typical development is necessary, some attempts have been made to use frequency as a parameter in the selection of treatment targets for children with phonological delay.

30.3.4 *Word frequency and neighborhood density in phonological treatment*

The majority of the work in this area comes from Gierut and colleagues in their investigations of the role of lexical factors such as word frequency and phonological neighborhood density on patterns of change in the productive phonology of children with functional phonological delay (Gierut & Storkel, 2002; Gierut, Morrisette, & Champion, 1999; Morrisette, 1999). Phonological neighborhood density refers to similarity relationships among words in an individual's lexicon; the lexicon is thought to be organized around groups of words that share similar phonological properties. Most often, phonological neighbors are defined as words that differ from each other by only one phoneme substitution, deletion, or addition in any position (Luce & Pisoni, 1998). Thus, the words *hat*, *cap*, and *cast* would all be neighbors of the word *cat*. Words that have many neighbors are said to reside in high-density neighborhoods, while words that have few or no neighbors are said to reside in low-density or sparse neighborhoods. Phonological neighborhood density may be compared to the usage-based concept of type frequency; phoneme sequences that occur in many words would have high type frequency and would create high-density phonological neighborhoods. The studies of Gierut and colleagues provide some evidence that the use of high-frequency and low-density words as treatment targets significantly facilitates generalization of the treated sounds to untreated words (Gierut, Morrisette, & Champion, 1999). In almost all cases, treatment using high-frequency words promoted generalization when compared to all other conditions, and treatment using high-density words inhibited generalization.

In one of the few articles to consider clinical applications of a usage-based phonology, Ball (2003) notes that this approach suggests that stressing contrast is less important in disordered phonology than the reinforcement of networks containing sounds and sequences of sounds that are problematic for the client.

30.4 Conclusion

A usage-based framework may offer an excellent opportunity for the integration of developmental and clinical phonology with general linguistic theory. Specifically, the emphasis placed on the intimate relationship between the lexicon and other aspects of the grammar, including phonology, may help us better understand phonological phenomena observed in children with both typical and disordered phonology. Furthermore, this new way of thinking about

phonology may lead to important changes in treatment for phonological disorders. Many clinicians have probably selected treatment words for individual children simply because it's a word that the child says a lot; further research evaluating treatment techniques grounded in usage-based phonology may show that those clinical intuitions were right on the mark.

REFERENCES

Ball, M. J. (2003). Clinical applications of a cognitive phonology. *Phoniatrics, Logopedics, Vocology*, 28, 63–9.

Beckman, M. E. and Edwards, J. (2000). Lexical frequency effects on young children's imitative productions. In M. B. Broe and J. B. Pierrehumbert (eds.), *Acquisition and the Lexicon*, Papers in Laboratory Phonology, V (pp. 208–18). Cambridge: Cambridge University Press.

Bybee, J. (1985). *Morphology: A Study of the Relation between Meaning and Form*. Amsterdam: John Benjamins.

Bybee, J. (2000). The phonology of the lexicon: Evidence from lexical diffusion. In M. Barlow and S. Kemmer (eds.), *Usage-based Models of Language* (pp. 65–85). Stanford, CA: CSLI Publications.

Bybee, J. (2001). *Phonology and Language Use*. Cambridge: Cambridge University Press.

Chomsky, N. and Halle, M. (1968). *The Sound Pattern of English*. New York: Harper & Row.

Ferguson, C. A. and Farwell, C. B. (1975). Words and sounds in early language acquisition. *Language*, 51, 419–39.

Gierut, J., Morrisette, M., and Champion, A. (1999). Lexical constraints in phonological acquisition. *Journal of Child Language*, 26, 261–94.

Gierut, J. and Storkel, H. (2002). Markedness and the grammar in lexical diffusion of fricatives. *Clinical Linguistics and Phonetics*, 16, 115–34.

Gregory, M., Raymond, W., Bell, A., Fosler-Lussier, E., and Jurafsky, D. (1999). The effect of collocational strength and contextual predictability in lexical production. *Chicago Linguistic Society*, 35, 151–66.

Jakobson, R. (1968) (trans. A. R. Keiler). *Child Language, Aphasia, and Phonological Universals*. The Hague: Mouton. Originally published as *Kindersprache, Aphasie, und allgemeine Lautgesetze*. Uppsala: Almqvist and Wiksell, 1941.

Johnson, K. (1997). Speech perception without speaker normalization. In K. Johnson and W. Mullennix (eds.), *Talker Variability in Speech Processing* (pp. 145–65). San Diego, CA: Academic Press.

Kemmer, S. and Barlow, M. (2000). Introduction: A usage-based conception of language. In M. Barlow and S. Kemmer (eds.), *Usage-based Models of Language* (pp. vii–xxviii). Stanford, CA: CSLI Publications.

Langacker, R. (1987). *Foundations of Cognitive Grammar. Volume 1: Theoretical Prerequisiites*. Stanford, CA: Stanford University Press.

Langacker, R. (2000). A dynamic usage-based model. In M. Barlow and S. Kemmer (eds.), *Usage-based Models of Language* (pp.1–63). Stanford, CA: CSLI Publications.

Leonard, L. and Ritterman, S. (1971). Articulation of /s/ as a function of cluster and word frequency of occurrence. *Journal of Speech and Hearing Research*, 14, 476–85.

Luce, P. A. and Pisoni, D. B. (1998). Recognizing spoken words: The neighborhood activation model. *Ear and Hearing*, 19(1), 1–36.

Morrisette, M. (1999). Lexical characteristics of sound change. *Clinical Linguistics and Phonetics*, 13, 219–38.

Pierrehumbert, J. (2001). Exemplar dynamics: Word frequency, lenition and contrast. In J. Bybee and P. Hopper (eds.), *Frequency and the Emergence of Linguistic Structure* (pp. 137–57). Amsterdam: John Benjamins.

Pierrehumbert, J. (2003). Phonetic diversity, statistical learning, and acquisiiton of phonology. *Language and Speech*, 46, 115–54.

Pinker, S. (1991). Rules of language. *Science*, 253, 530–5.

Pinker, S. (1999). *Words and Rules: The Ingredients of Language*. New York: Basic Books.

Prince, A. and Smolensky, P. (1993). *Optimality Theory: Constraint Interaction in Generative Grammar*. Malden, MA: Blackwell.

Stampe, D. (1969). The acquisition of phonetic representation. Papers from the Fifth Regional Meeting of the Chicago Linguistic Society, 443–54.

Stoel-Gammon, C. and Cooper, J. (1984). Patterns of early lexical and phonological development. *Journal of Child Language*, 11, 247–71.

Tyler, A. and Edwards, J. (1993). Lexical acquisition and acquisition of initial voiceless stops. *Journal of Child Language*, 20, 253–73.

Velten, H. V. (1943). The growth of phonemic and lexical patterns in infant language. *Language*, 19, 231–92.

Vihman, M. M. (1992). The construction of a phonological system. In B. de Boysson-Bardies, S. de Schonen, P. Jusczyk, P. MacNeilage, and J. Morton (eds.), *Developmental Neurocognition: Speech and Face Processing in the First Year of Life*. Dordrecht: Kluwer Academic Publisher.

Zamuner, T. S., Gerken, L., and Hammond, M. (2004). Phonotactic probabilities in young children's speech production. *Journal of Child Language*, 31, 515–36.