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Nexus to Lexis: Phonological Disorders in Children

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Abstract

Research on phonological disorders in children has conventionally emphasized the speech sound in search of causes, diagnoses, treatments and prevention of the disorder. This paper aims to shift the research focus to the word instead. The motivation comes from advances in psycholinguistics that demonstrate the word is central to the perception, production and acquisition of phonological information. Three strands of potential study are outlined in evaluation of how words might initiate and boost, but perhaps also, interrupt learning for children with phonological disorders.

Keywords

Lexicon; phonology; phonological disorders; phonological treatment

The process of phonological acquisition requires that a child learn the unique sounds, sound contrasts and sound patterns of words, and represent these in the mental lexicon for purposes of differentiating meaning in language. For children with phonological disorders, this process is disrupted. Characteristically, these children have a reduced consonantal inventory that is comprised largely of nasals, stops and glides to the exclusion of other consonants, which results in misarticulations and unintelligibility. Children with phonological disorders also fail to mark contrasts among sounds in the differentiation of meaning, which leads to homonymy and miscommunication. These constraints on phonological structure and function further impact the quality of children's lexical representations, with a general view that the phonological properties of words are poorly specified.[1,2] Moreover, the disorder poses significant health and educational concerns as one of the most common language learning disabilities in childhood. The population constitutes the majority on the caseloads of clinicians serving the public schools.[3] Beyond that, those with phonological disorders often experience life-long linguistic challenges that impact their educational and occupational attainment.[4,5]

The significance of these risks has prompted vigorous and varied research to identify causes, conditions, treatments and prevention of the disorder. Some have adopted a biological tack in an effort to isolate phenotypes and genotypes for insight into why more boys than girls are affected, and why the disorder seems to run in some families.[6] Others have taken a correlational approach in documenting the co-occurrence of phonological disorders with

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other conditions such as otitis media, disfluency or specific language impairment.[7–9] Descriptive linguistic, perceptual and acoustic work has resulted in fine-grained characterizations of children's phonologies for insight to their knowledge of the target grammar.[10–12] Experimental treatment research has spawned new methods of instruction with demonstrations of treatment efficacy to support evidence-based clinical practice.[13] Yet, despite progress on these and other fronts, phonological disorders remain functional in nature. Its origins are unknown and there is no predictive basis for its occurrence or extent of impact on other skills. There are degrees of ambiguity in differential diagnosis, and prescriptions for treatment that are tailored to a given child's unique constellation of skills are lacking. The means for prevention have not been identified. Clearly, all of these issues warrant deeper and continued study; but, as we look to the future for breakthrough discoveries, it might be wise to follow the lead of research on other complex systems, diseases and disorders. Oftentimes, the answers to long-standing questions are found by stepping outside the bounds that define the conventional research agenda.[14] In doing so, there is the promise of paradigmatic shifts in the conceptualization, diagnosis, treatment and/or prevention of a condition.

In this regard, there is a case to be made for the study of phonological disorders. To date, the research and clinical agenda has largely centered on the speech sound: Which sounds are in a child's inventory? Which sounds are used as substitutes? What is the percent accuracy of sound production? Which sounds are targeted for treatment? Indeed, the term 'speech sound disorder' is often used to reference the population. On the one hand, the attention given to speech sounds seems appropriate because behaviorally, children's phonologies are affected. On the other hand, the original and seminal studies of phonological acquisition and disorders pointed in a very different direction. Visionaries like Roman Jakobson, Charles Ferguson and others cited the word as being the heart of phonology.[15–18] Their view was that phonological acquisition and disorders arise as a consequence of the lexicon, such that the structure, function and representation of sounds are by-products of learning new words. If the visionaries were correct, then the research agenda might be better positioned in the study of words and word learning, with the implication that the origins, diagnosis, treatment and prevention of phonological disorders may lie in the lexicon. In its strongest form, the hypothesis is that phonological disorders may be a behavioral masquerade, which obscures a fundamental problem associated with learning and representing words in the mental lexicon. Empirical support for this proposal would have sweeping consequences for the theoretical conceptualization and clinical management of phonological disorders because it would take the disorder out of the domain of phonology and move it to the lexicon. In its weak form, phonology and the lexicon may be in a mutually beneficial relationship, such that the properties of words influence the emergence of sounds and vice versa.[1] Indeed, there is burgeoning new evidence in the psycholinguistic literature to support the latter, such that the properties of words differentially affect perception, production and learning. Further support for this proposal would contribute on the theoretical side, to honing the distinction between grammar and the lexicon and on the clinical side, to choosing words for treatment to maximize phonological learning.

The purpose of this paper is to capitalize on the psycholinguistic developments by reframing the research focus to emphasize the word and its impact on phonological disorders in

children. We pose three questions: How does phonology emerge from words? Which words boost phonological learning? And, what is the process of learning words that, if interrupted, holds consequences for phonological learning? For each question, we summarize hypotheses from the psycholinguistic literature. Preliminary data from children with phonological disorders are then reported in the context of these proposals. The data, in turn, serve to motivate potential lines of future study.

How Does Phonology Emerge From Words?

The *lexical restructuring hypothesis* is a developmental proposal that describes how learning new words promotes the acquisition of phonology.[19] The premise is that, when a child begins to learn words, the representations of those words are primitive and lack phonological detail, perhaps being marked only for canonical (CV) structure. As the child learns new words, the lexicon grows in size, making the (gross) representational strategy inefficient. The reason is that multiple words will have the same phonological form (e.g., ‘mom’ and ‘dog’ are both CVC), making them indistinguishable. To resolve the ambiguity, the child must elaborate the phonological content of words by introducing and representing new phones, phonemes and contrasts. Presumably, the way this takes place is akin to long-term auditory word priming.[20] Priming is a classic psycholinguistic paradigm that involves the presentation of a set of experimental items similar to a test item to facilitate a behavioral response (e.g., ‘nurse’ is a semantic prime of ‘doctor’). In typical phonological development, priming takes place naturally through repeated exposure to phonologically similar sounding words in the input. However, for children with phonological disorders, explicit comparisons of minimal pairs are needed to induce lexical restructuring in elaboration of phonological representations.[21]

These hypotheses were tested in preliminary studies that employed priming in treatment of children with phonological disorders.[22,23] In each session, children listened to a series of stories, and then advanced to treatment aimed at accurate sound production. For some children, the stories contained minimal pairs of the words that were taught in production. Figure 1 (left panel) shows an example of one such story used in treatment of /r/. Notice that a treated word ‘rat’ and corresponding story words ‘fat, bat, cat’ and so on are phonologically related minimal pairs, unique in onsets but overlapping in rimes. This condition provided children with explicit and repeated exposure to similar sounding words in parallel to the case of developmental priming described above. For comparison purposes, other children were exposed to stories prior to treatment of production, but the treated and story words were unrelated (Figure 1, right panel). Results showed that, when children were exposed to phonologically related stories, there was greater phonological gain in accuracy, learning and generalization as compared to the unrelated story condition. Learning was greatest in dual modalities, where children heard stories and saw corresponding pictures as compared to only hearing stories or only viewing pictures. Likewise, learning was greatest when stories came before treatment of sound production, not after. The early findings thus accord with the hypothesis that children with phonological disorders require explicit exposure to minimal pairs, as in the form of priming, to promote lexical restructuring.

The initial results are intriguing because they open the door for continued clinical and theoretical study. On the clinical side, priming seems to be a viable treatment method, but the details need to be worked out. One detail relates to the optimal prime stimuli. Preliminary studies employed rime primes, where treated and story words overlapped in VC structure; however, onset primes are another alternative. Under this scenario, treated and story words would share the same onset, but vary in rimes. For example, if the treated word were ‘rat’, corresponding story words might be ‘run, rabbit, red’. Mixed sets of words are still another possibility, where combinations of the onset and rime primes would be used. It is known that mixed sets are more difficult to acquire, but they do result in broader linguistic generalizations about the input,[24] which may attest to improved efficacy.

Other clinical questions relate to the format of priming. Preliminary work relied on stories to provide contextual meaning for minimal pairs, but it is plausible that citation lists will be equally effective. Simply hearing a sequence of minimal pairs may aid learning for children with disorders. The ideal number of prime words in a given story needs to be established, as does the frequency of administration. Preliminary work introduced no more than 10 minimal pair occurrences in stories and priming was administered every treatment session. This format may be inversely related: Increasing the number of minimal pairs in stories may decrease the frequency of administration, but this needs to be verified. Timing of exposure to stories, either before or after treatment of sound production, also needs to be revisited, particularly with respect to individual differences. Preliminary studies support the efficacy of priming before treatment, but some subsets of children may benefit more from exposure to stories after treatment. This may be the case for children with co-occurring deficits in phonology and working memory. For this subgroup, stories after treatment of production may solidify the phonological properties of the treated words in working memory by refreshing the phonological loop through activation of similar sounding minimal pairs. Still other subgroups may require exposure to stories both before and after treatment of production. The answers to these and other clinical questions will contribute to evidence-based practice by defining and refining priming as a method of treatment. Fresh perspectives on the classic method of auditory bombardment[25] will arise because the evidence from priming will specify which words to bombard, how to bombard, when to bombard, and how long to bombard in phonological treatment.

On the theoretical side, the causal effects of priming need to be determined, with particular attention to why children with phonological disorders might need explicit exposure to minimal pairs for lexical restructuring. One possibility is that priming reflects a novelty effect. Through repeated exposure to minimal pairs in stories, the child’s attention may be drawn to unique phonemic distinctions as overlapping phonological structure habituates. Children with phonological disorders may require ramped up attention to optimize learning. Another possibility is that priming promotes the formation of linguistic generalizations. It may be that priming any set of minimal pairs will facilitate phonological learning, independent of relationships between treated and story words. For example, potential story words ‘dog, hog, fog’ highlight phonemic distinctions /d h f/, but are not in a minimal pair relationship with other potential treated words to correct production of /r/, such as ‘rat, red, race’. Nonetheless, this scenario may help the child abstract linguistic generalizations that then extend across the phonology;[26,27] namely, that phonemic contrasts occur and are

relevant in the differentiation of meaning. Yet another possibility is that priming serves a domain-general purpose. A recent phenomenon dubbed the 'Seuss boost' has shown that the simple exposure to rhyming words (minimal pairs) has sweeping and positive effects on children's recognition, identification, memory, retention and learning of language.[28] Priming may assist children's general cognitive functioning, independent of anything specific to phonology. By exploring these and other hypotheses, insights will be broadened to inform the role of attention, generalization and cognition in lexical restructuring by children with phonological disorders.

Which Words Boost Phonological Learning?

Complementary hypotheses from the psycholinguistic literature build on usage-based models of language acquisition.[29] The premise is that children attend not only to qualitative, but also quantitative information in the input to guide phonological acquisition. Quantitative data are culled from frequencies and likelihoods of occurrence, which provide cues about the regularity and predictability of structure, with properties occurring more often being more robust. Presumably, the child keeps track of, and encodes quantitative cues associated with lexical and sublexical structure. Lexical cues reference the word as a whole unit and include, for example, the frequency of word occurrence, corresponding age-of-word-acquisition, word familiarity and neighborhood density. *Neighborhood density* is a tally of the number of minimal pair counterparts to a given word, with words that are phonologically similar clustering together in lexical organization.[30] Words with many minimal pair counterparts form dense neighborhoods (e.g., 'cat'); those with few minimal pair counterparts form sparse neighborhoods (e.g., 'gopher'). By comparison, sublexical cues reference the sounds and sound sequences internal to the word. Sublexical cues include segmental frequency independent of context (coronals /t d/ occur more often than dorsals /kg/ in English) and phonotactic probability. *Phonotactic probability* is the statistical likelihood of occurrence of sounds and sound sequences by context (e.g., in English, /b/ is more common in initial position than /z/, and the VC sequence /ol/ is a more common word ending than /os/[31,32]). Together, any given word is associated with a rich set of lexical and sublexical cues in the input, and these cues further affect perception, production and learning. When cues converge, processes are facilitated; when cues collide or compete, processes are inhibited. Thus, cues are dynamic, waxing and waning with the strength of effects influenced by a child's attunement to the regular and predictable properties of words.

The effects of lexical and sublexical cues on phonological development have been well documented,[1] and are of special interest to the study of phonological disorders, both for comparison purposes across populations and as a means for promoting phonological learning in clinical treatment. Considerable progress has been made due to the availability of innovative web-based tools with computational search functions that make it possible to define the lexical and sublexical properties of given words and sounds. Lexical databases provide statistics about such cues as word frequency, neighborhood density and age-of-word-acquisition.[33] Other on-line calculators make it possible to compute phonotactic probability.[32,34] Such tools have been invaluable to the design of experimental research, but are equally relevant to clinical practice in choosing stimuli for phonological treatment.

Despite research and clinical potential, the findings pose certain challenges in deciphering relevant cues for children with phonological disorders. On the one hand, the results from some studies converge and are consistent with patterns of typical phonological development. For example, greater production accuracy, learning and generalization are associated with high frequency words as compared to low frequency words; high frequency words are thus recommended as stimuli of treatment.[35–37] Similarly, words that are late acquired facilitate greater phonological learning and generalization as compared to other early acquired words; late acquired words are likewise recommended for treatment.[37,38] On the other hand, the findings from other studies reveal asymmetries that, while puzzling, open the door for future research. To illustrate the broad possibilities, we consider examples from the study of neighborhood density as a lexical cue and nonwords as a sublexical cue relative to treatment of phonological disorders.

Neighborhood Density

Neighborhood density is critical to lexical restructuring in typical development. When many similar sounding words cluster together to form a dense neighborhood, the lexical representation of each word must be rich in phonological detail so as to be unique and differentiated from other words in the same neighborhood.[39] If true, then words from dense neighborhoods might be appropriate as stimuli in phonological treatment because they may likewise force the emergence of phonology. This hypothesis was put to test in a series of studies that provided children on treatment of sounds in words from dense versus sparse neighborhoods,[40–42] with mixed results. Some work reported greater production accuracy, learning and generalization in connection with words from sparse neighborhoods.[40,41] This departs from the pattern of typical development,[1] hinting of potential population differences. Yet, other work showed greater phonological learning in treatment of sounds in words from dense neighborhoods,[42] aligning with typical development. The switch took place only when neighborhood density was coupled with word frequency, and further, when the combination of the two cues was uniform across treated words, e.g., all frequent words from dense neighborhoods or all infrequent words from dense neighborhoods. This hints that children with disorders may require both the coupling and consistency of cues to achieve phonological learning in a way that is on par with typical development.[42] A single cue may not provide enough information, and variability in cues may further mask input regularities. Nonetheless, the data support the general hypothesis that input cues wax and wane in collusion and competition to affect phonological learning.

With this in mind, several new lines of investigation are needed to better understand how children with phonological disorders use quantitative cues, and how cues may best be incorporated in treatment. A baseline that documents learning effects for the complete range of lexical and sublexical cues must be established and replicated. Thus far, density, word frequency, age-of-word-acquisition and phonotactic probability have been examined across studies, but other properties such as imageability, concreteness, familiarity or semantic set size need to be considered. The independent contribution of a given cue must be assessed, and then cues must be evaluated in combination. This will reveal the differential relevance and weighting of cues that affect phonology. While cue pairing is an important step,

eventually multiple cues will need to be examined in concert because the child is routinely confronted with a whole complex of quantitative information in the real world input.

Related work on correlations among cues needs continued attention. It is well established, for example, that density is correlated with length and phonotactic probability: Words in dense neighborhoods tend to be shorter and composed of common sounds of the language.[32,43] Similarly, word frequency is inversely correlated with age-of-word-acquisition: Frequent words tend to be early acquired.[44] Correlated cues are interesting because the data dovetail to potentially reinforce predictability and regularity of structure; yet, the unique contribution of each cue must be disambiguated to determine which is most basic. Preliminary work suggests too that cues may have different functions: Density seems to aid the creation of phonological representations in memory, whereas phonotactic probability seems to confirm the permissibility of sound sequences.[45] If cues do, in fact, serve different purposes, this may bear on individual differences. In treatment, cues may be matched to a child's unique profile and needs.

Context is another consideration for future research because cues vary in strength by word position. In English, for example, sounds in the final position of words tend to be more robust than those in initial position.[31] Fewer sounds are permissible in final position; consequently, these sounds occur more often, rendering them more predictable. The intersection of cues and context has yet to be initiated in the study of children with phonological disorders, but is potentially significant because children's errors are often restricted by word position, e.g., final consonant deletion or initial velar fronting.

Three additional methodological issues are worth mentioning, which may reconcile observed discrepancies across studies. First, cues have been conventionally conceived of as binary variables (e.g., dense versus sparse neighborhoods), when, in fact, they lie on a continuum. Moreover, the criteria to define binary distinctions have been arbitrary and vary by study. New work is needed to examine cues as continuous properties to better align with the input the child receives in the real world environment. Second, cues have been differentially operationalized using a variety of lexical databases. There has been considerable debate in the literature about whether cues should reflect the properties of the child's emerging lexicon or the adult end-state grammar, as this is what the child is striving to learn.[39,46,47] Issues of continuity in language learning across the lifespan favor the adult model, but work is needed to empirically establish which approach best captures the behavioral effects.[48] Finally, the task and dependent variable need to be taken into account as these too have varied across studies. Behavioral manipulations span, for example, nonword repetition, similarity judgment, gating and learning tasks, and measurements include duration, accuracy, error and generalization. Comparative work is thus needed to determine the waxing and waning of cues by task in order to take advantage of the paradigms that maximize performance.

Nonwords

Nonwords have long been a staple of phonological treatment,[25] but take on significance from the perspective of quantitative cues. It is thought that nonwords activate sublexical structure associated with the internal sounds and sound sequences of words.[49] Nonwords lay

outside the lexicon. Consequently, the only information a learner can grasp is the nonword's phonological structure. For this reason, nonwords might be an important element of treatment given children's phonological needs. Indeed, when a nonword is paired with a known referent (e.g., known noun), children learn the treated sound with greater accuracy of production.[50] Similarly, when a nonword is paired with a new referent (e.g., novel noun), phonological learning occurs immediate to treatment, with gains in both accuracy of production and generalization.[51,52] Moreover, nonwords in treatment reduce the range of substitutions and variability in children's productions.[53] Yet, the nonword advantage may be confined to treatment. While nonwords facilitate learning during treatment, phonological learning plateaus after treatment is withdrawn, with few added gains to the phonology over time.[52]

To understand the utility of nonwords for children with phonological disorders, a series of questions must be addressed. One relates to the operational definition of a nonword. Guidelines are needed to establish the nonword format that best promotes production accuracy and learning. 'Wordlikeness' is one consideration: If a nonword closely resembles a real word, productions are more accurate.[54] Similarly, nonwords comprised of common sounds are repeated with greater accuracy.[55] These and other factors (e.g., word length, syllable structure, stress) will need to be incorporated into the definition of nonwords to maximize learning. Work along this line has been initiated in an effort to lend uniformity across experimental studies.[56] The applied potential lies in the opportunity to extend such definitions in creating proper sets of nonwords to heighten the effects of phonological treatment.

Other questions bear on clinical guidelines for deciding when to use nonwords in phonological treatment. Continued comparisons of nonwords versus real words are in order to evaluate the independent and also, sequential application of nonwords followed by real words and vice versa. It is possible that nonwords will be most effective in the early phase of intervention to introduce new phonological structure, with real words to follow as stimuli that reinforce that structure in the lexicon. Future research might also explore individual differences, with a focus on identifying the candidates for nonword treatment. Some children may show a nonword and others, a real word advantage. Also, a child's presenting profile may influence nonword applications. Studies have shown that vocabulary size impacts children's performance on nonword repetition tasks and learning in treatment.[55,57] For treatment in particular, children with large vocabularies evidence greater learning when nonwords are comprised of common sounds; whereas those with small vocabularies learn best when nonwords consist of rare sounds.[57] Thus, nonwords may need to be tailored to suit each child's presenting profile.

Two final issues in the use of nonwords are likely to be more challenging. One relates to the lifeline of nonwords. Consider that every time the child acquires a new word, that word starts out as a nonword because its phonological form and meaning are unknown. An obvious question then is why not teach using real words that lie beyond the child's current vocabulary? In essence, this should resemble treatment of nonwords, and affords ecological validity and dual opportunities for phonological and lexical expansion. The challenge, however, lies in establishing which words the child knows and which remain to be learned.

For this, more sensitive lexical assessments need to be developed.[58] A related issue involves disambiguating the distinct contributions of form and meaning in nonword applications. Uniformly, nonwords are paired with referents in experimental and clinical work. This leaves open the question of whether nonwords benefit phonological learning due to their form, meaning, or both. While results have conventionally been attributed to phonological form, greater attention needs to be given to the role of meaning in phonological learning. The distinct contributions of form versus meaning are especially important if it is indeed found that the underlying problem for children with phonological disorders is learning new words.

How Are New Words Added To The Lexicon?

It has long been established that word learning takes place rapidly, seemingly without effort and continuously across the lifespan. Only recently, however, has word learning been explored more deeply to discover a multistep process. One psycholinguistic model describes the steps as triggering, configuration and engagement.[59] *Triggering* alerts the learner to the novelty of a new word such that it is unlike any other in the lexicon. This is the clue to the learner that a new lexical entry must be formed. *Configuration* involves assembly of the lexical representation, where the internal sound structure of the word is put into place. Consistent with the lexical restructuring hypothesis, the representation is built from primitive, and then elaborated, phonological structure. *Engagement* seats the representation in the lexicon as a full-fledged member of a neighborhood. Connections are formed to bind the new word to other known words in the lexicon based on their shared phonological structure. This then creates opportunities for facilitation, inhibition or competition in perception, production and learning.

Extension of this model to language development is just beginning, but the initial results are promising. In particular, children with phonological disorders seem less adept in the multistep process of adding words to the lexicon as compared to their typical peers. Preliminary studies[58,60,61] report that children with phonological disorders show signs of triggering: They seem to know and readily acquire words that reside in sparse neighborhoods and contain rare sounds. These conditions showcase the novelty of a word because sparse neighborhoods have few phonologically similar words, and rare sounds occur less often in the language. This uniqueness calls for a new lexical entry, consistent with the description of triggering. Configuration and engagement, on the other hand, appear to be compromised for children with phonological disorders. Children are less skilled in knowledge and acquisition of words residing in dense neighborhoods and containing common sounds. These two conditions, in principle, should provide the necessary scaffolding for assembling a new representation because dense neighborhoods consist of many words that are similar in phonological structure, and common sounds are robust occurrences. Building a new lexical entry from a familiar template should further strengthen the links between new and known words to enable engagement. This, however, seems not to be the case for children with phonological disorders: Adding new words to the lexicon may be disrupted, at least in part. By comparison, children with typical development show signs of all three steps—initiating, forming and grounding new representations in the lexicon—whether new words reside in dense or sparse neighborhoods and contain common or rare

sounds. This hints that children with phonological disorders may indeed have limitations acquiring words, endowing those words with rich phonological structure and embedding those words in the mental lexicon. The observation is consistent with the hunch of the early research visionaries and inspires the need for a shift in research emphasis from the sound to the word.

As the science moves forward, a two-pronged approach, involving methodological and empirical work, will help break new ground. On the methodological side, innovative tools are needed, possibly borrowed from psycholinguistics and adapted to the study of development and disorders. These might include instrumental tools (e.g., evoked response potential, eye-tracking) to establish the locus of effects in word learning as phonological, lexical or semantic. Behavioral paradigms (e.g., lexical decision, novelty detection) are needed to differentiate the multistep process of triggering, configuration and engagement. Analytic procedures (e.g., effect size for single-subject design) are crucial for gauging the magnitude of word versus phonological learning in comparative studies.

On the empirical side, the research possibilities are wide open, with one important suggestion. If the aim is to uncover the origins, roles or interactions between word and phonological learning, then both sets of skills must be evaluated concurrently in experimental work. By comparison, the approach thus far has measured lexical skills to the exclusion of phonology, and vice versa. If word learning turns out to be the crux of the problem for children with phonological disorders, then it will be necessary to demonstrate that this process has a direct and unilateral impact on children's phonologies and phonological learning. Alternatively, if phonological learning is independent of, but mediated or moderated by word learning, then it will be necessary to demonstrate that the processes have distinct heterochronic developmental trajectories. Whatever the outcome, the vision for future research that is outlined herein is likely to expand, deepen and challenge our notion of phonological disorders in children, with applied promise for clinical diagnosis, treatment and prevention.

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CEU Questions with Answers in Boldface

1. Which best describes neighborhood density?

- **a.** An assessment of vocabulary
- **b.** An experimental paradigm that is used in psycholinguistic research
- **c.** The age at which a given word is acquired
- **d.** **Words with overlapping phonological structure that provide organization to the lexicon**
- **e.** The frequency of occurrence of a sound in the language

2. Which is an example of a lexical cue to phonological structure?

- **a.** Phonotactic probability
- **b.** **Age-of-word-acquisition**
- **c.** Novelty effects
- **d.** Triggering, configuration and engagement
- **e.** None of the above

3. What is phonotactic probability?

- **a.** The frequency of occurrence of words in the language

b. A lexical cue to phonological structure

c. The degree to which a nonword resembles a real word in the language

d. The concreteness of a word

e. **The likelihood of occurrence of sounds and sound sequences by context in the language**

4. What is lexical restructuring?

a. An innovative tool with computational search functions that specify lexical and sublexical cues for individual words

b. Habituation to words with overlapping phonological structure

c. A learner's ability to recognize that a new word does not have a corresponding lexical entry

d. Engagement of the representation as a full-fledged member of a lexical neighborhood

e. **A developmental shift in the phonological representation of words that occurs with increases in lexical size**

5. Which research finding has been borne out in the literature?

a. When nonwords closely resemble real words, children's repetition accuracy is compromised

b. During priming, greater phonological learning occurs when children see pictures

of minimal pairs in the absence of corresponding auditory input

c. **Children with phonological disorders have difficulty configuring and engaging the representation of new words**

d. For children with small vocabularies, nonwords are more readily learned than real words

e. None of the above

Learning Outcomes

After reading this article, the learner should be able to (1) describe the lexical restructuring hypothesis in the context of phonological acquisition; (2) differentiate lexical from sublexical cues and provide examples of each; and (3) summarize the multistep process of adding new words to the lexicon.

Treated Word	Related Minimal Pairs	Picture Stimulus	Unrelated Words
rat	'Where is the fat bat?' called the cat. 'I want to have a chat!' She looked in the hat and under the mat. Then she sat. 'Oh where is the fat bat at?'		I know he is hiding, but he's tough to find. I looked under the pad and searched every spot. I know he has wings, but he's not in the air. Can he disappear?

Figure 1.

Sample prime stories for treatment of the word 'rat' in two experimental conditions. The story on the left employs minimal pairs related to the treated word, whereas the story on the right employs unrelated words.