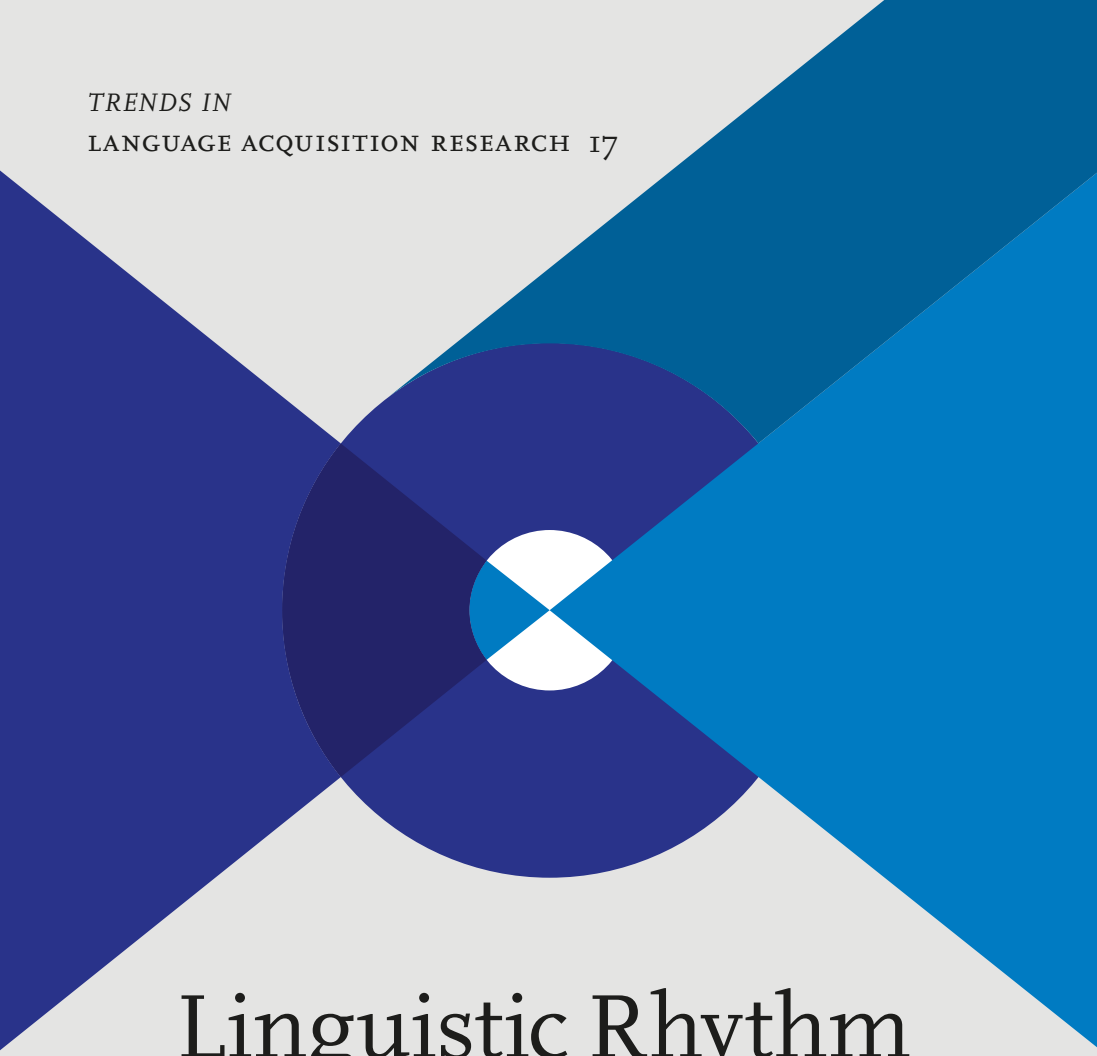
TRENDS IN
LANGUAGE ACQUISITION RESEARCH 17



Linguistic Rhythm and Literacy

Edited by
Jenny Thomson and Linda Jarmulowicz

JOHN BENJAMINS PUBLISHING COMPANY

Linguistic Rhythm and Literacy

Trends in Language Acquisition Research

ISSN 1569-0644

TiLAR publishes monographs, edited volumes and text books on theoretical and methodological issues in the field of child language research. The focus of the series is on original research on all aspects of the scientific study of language behavior in children, linking different areas of research including linguistics, psychology & cognitive science.

For an overview of all books published in this series, please see *http://benjamins.com/catalog/tilar*

Volume 17

Linguistic Rhythm and Literacy
Edited by Jenny Thomson and Linda Jarmulowicz

Linguistic Rhythm and Literacy

Edited by

Jenny Thomson
University of Sheffield

Linda Jarmulowicz
University of Memphis

John Benjamins Publishing Company
Amsterdam / Philadelphia

DOI 10.1075/tilar.17

Cataloging-in-Publication Data available from Library of Congress:
LCCN 2015041507 (PRINT) / 2015047134 (E-BOOK)

ISBN 978 90 272 4407 9 (HB)
ISBN 978 90 272 6755 9 (E-BOOK)

John Benjamins Publishing Company · https://benjamins.com

Table of contents

Introduction

Being literate opens up economic and social opportunities at the level of the individual as well as at the level of nations. Yet becoming literate is not an easy or automatic endeavour. For decades researchers have tried to identify the factors that contribute to individual variability in reading skill. As a result of this concerted effort, it is now understood that in alphabetic languages one of the most robust predictors of successful reading and spelling acquisition is phonological awareness (PA), the ability to reflect upon and manipulate the sounds of one's language. The incorporation of phonological awareness activities into early literacy curricula has been a powerful consequence of this research (Report of the National Reading Panel, 2000). However, while a significant subgroup of children still struggle to acquire basic literacy skills, important questions remain concerning both the precursors of PA as well as the variance in reading ability not attributable to PA. More recently, a number of studies have emerged from a range of academic disciplines and languages that highlight the role of linguistic rhythm as an influential factor in reading development.

Linguistic rhythm does not easily assume a single definition, which is part of the motivation for this volume. Across the epistemologies of different disciplines, we explore whether common ground can be identified and built upon.

A key aspect of linguistic rhythm is prosody, which traditionally has played a supporting role in language processing and literacy. The assumption that phonemes or larger units are primary and prosody is simply overlaid or superimposed on top of phonemic segments may be part of the reason for this. Indeed, just the word suprasegmental perpetuates this assumption. The segments must already be present for the suprasegmental features to adhere to. We would like to take a different view. Rather than think of the phoneme as primary and the prosody as secondary, one could think of the segments as suspended in a prosodic environment. The prosodic environment, although suprasegmental in its expression, is a complex system that intertwines perception and interpretation of the signal; storage, retrieval, and production of prosodic units; and integration of the auditory percept with orthographic representations. This system may interact with the segmental/phonemic system, but that does not mean we should discount prosody. As an analogy, think of a bird in flight. What we notice is the bird, swooping and soaring. What we do not notice is the air or the air currents, but without those critical elements there is no flight, no swooping, no soaring. But

DOI 10.1075/tilar.17.001int

birds are more obvious than the air, much easier to identify. Similarly, phonemes have received the bulk of attention in the literacy literature, achieving superstar status in the last 20 years. They are a fairly easily defined set, unlike the prosodic environment which they inhabit. Essentially, we are beginning to examine the importance of the prosodic environment in which phonemes are suspended and its relation to literacy.

The terms we use in this volume inherently give rise to confusion. We do not claim to have the precise definition, and the chapters presented here may use the terms in slightly different ways. Nevertheless, we attempt to clarify for the reader the meanings of terms such as *prosody*, *suprasegmentals*, *intonation*, and *rhythm*. In the event we cannot completely clarify the terms, our hope is that we shed light on the semantic nuances that exist across several disciplines.

Of the terms used in this volume, *suprasegmental* is the broadest. Segmental features correspond to individual phonemes and suprasegmental features apply across phonemes, syllables, words, and phrases and are the vehicle for both prosodic and paralinguistic information. Typically, suprasegmental refers to the acoustic, physical properties of the speech stream, including fundamental frequency, intensity, and duration of the signal (Shriberg & Kent, 2003). These acoustic features result in perception (a psychological interpretation) of pitch, loudness, and length respectively. These suprasegmental features can be used paralinguistically to express emotion or humour through voice quality, pitch, or rate. They can also be used systematically as organizational structures, which we refer to as linguistic prosody.

Prosody is studied by linguistic researchers as well as speech scientists, with slightly different parameters applied to the term by these two groups (Blevins, 1995; Hayes, 1995; Selkirk, 1980; Shriberg & Kent, 2003). From a linguistic point of view, prosody is a system of prosodic units or categories, such as the syllable, the foot, prosodic word, and prosodic phrase (Halle & Vernaud, 1987; Selkirk, 1980). Prosodic units interact with syntax and also affect phonetic realization of phonemes in adjacent words. The term prosody can also be found in the speech science literature as encompassing a broader range of phenomena including phrasing, pausing/tempo, rate, loudness, and stress (Shriberg, 1993). In both literatures, prosody is expressed through suprasegmental features.

Intonation frequently refers to extended pitch contours at the sentence or discourse level, and may also include paralinguistic phenomena through the use of speech rate or fluency (Ladd, 2008). Thus, both prosody and intonation are expressed through suprasegmental features, but the terms are not synonymous. Indeed, which is the umbrella term (prosody or intonation) is not clear in the literature. For the purposes of this volume, intonation is a prosodic event that extends over larger units (utterances and sentences).

Finally, the term *rhythm* may refer to beats or pulses of acoustic energy over time, and as such may reflect the melody of a language (Shriberg & Kent, 2003). *Rhythm* is also viewed as a linguistic and prosodic phenomenon that may occur within or across words, typically reflected in syllabic patterns of relative prominence. Study of linguistic rhythm may fall under metrical phonology (Hayes, 1995) and may involve syllable-, word-, or phrase-levels of analyses. Additionally, interest in differences in syllable durations or time between syllables also falls under the study of linguistic rhythm (Grabe & Low, 2002).

The intent of this volume is not to deny the importance of phonemes to speaking or to word reading; rather we aim to explore the range of interests in prosodic and rhythmic processes as they relate to literacy. The twelve papers collected here resulted from a gathering of researchers examining linguistic prosody. The group included linguists, psycholinguists, developmental psychologists, cognitive and neurocognitive scientists and educational researchers. However, the papers reflect a confluence of interest, across a range of methods and questions. They share the common thread of trying to understand the co-development and interaction between prosody, linguistic rhythm, and literacy across the lifespan. In Selkirk's prosodic hierarchy, there is a systematic increase in the size of the prosodic unit, stretching from phonemes and segments on the one end, up to intonational phrases on the other. Many layers of this hierarchy are represented in this volume. However, one deficit of linguistic structure models is that they tend to overlook the human processing part. Specifically, the nature of the representation, the way we measure it, and the modality we measure it in. We have included papers addressing different levels of representation, with a range of methods, spanning both written and oral modalities.

A key purpose of this volume is to explore the importance of these different aspects of the suprasegmental environment to literacy processing and development, however their overt manifestation in print is surprisingly minimal. A handful of languages, including Spanish (represented in this volume) and Modern Greek, mark stress in the orthography using accent diacritics. There are also derivational morphemes in English such as *ic, ity* and *tion* that are associated with systematic and predictable stress changes (Jarmulowicz & Taran, 2007), however such rules are typically not available at a conscious level to native speakers of the language. The influence of linguistic rhythm upon literacy is thus subtle, yet, we argue, key.

Overview of chapters

This book has three parts. In part one, *Prosodic Sensitivity & Literacy*, the papers are thematically united around their focus upon perception, sensitivity, and

awareness of linguistic rhythm and potential relations to the construct of literacy. The reader is exposed to a continuum of approaches that seek to understand how the human mind parses linguistic rhythm, from carefully designed assessments of overt awareness, through to the study of unconscious neural responses.

In the first chapter, **Wade-Woolley** and **Heggie** directly address the legitimacy of studying the role of prosodic awareness in reading development, independently of its potential overlap with the existing key predictor of early reading ability, phonological awareness at a segmental level. By systematically examining 10 peer-reviewed works that directly compare the statistical contribution of segmental phonology versus prosodic awareness measures in predicting reading skill, the authors conclude that measures of prosodic awareness appear to independently contribute variance to reading.

Looking at the same overt measures of prosodic awareness as predictors of reading, **Holliman** (Chapter 2) explores the whether specific aspects of prosodic awareness are stronger predictors of reading than others. If assessing prosodic awareness, independent of segmental phonological awareness, is to be a useful tool in early prediction of reading ability, should we consider it a unitary construct, or will it be more fruitful to look at specific aspects of prosodic awareness such as intonation, or lexical stress? Holliman reports a mixed picture, his work also demonstrating the difficulty of separating assessment of a prosodic feature from the additional cognitive processes involved in overt assessment, for example the relative demands of categorizing versus discriminating.

Mundy and **Carroll** (Chapter 3) further explore the interaction between prosodic factor and assessment format, this time in the context of adults with and without dyslexia. Reviewing many of the extant studies in this area, Mundy and Carroll reveal some intriguing patterns of findings. Interestingly, the use of priming tasks, which have a reduced task load in terms of overt awareness, reveal areas of intact prosodic awareness for adults with dyslexia, where similar, but more overt measures find reduced performance.

Harrison and **Wood** (Chapter 4) focus our attention upon a key application of understanding the relationship between prosody and literacy, that of literacy intervention. The discovery of the link between segmental phonological awareness and literacy has had a lasting impact on instructional methods for early reading across alphabetic languages, with explicit instruction in phonological awareness a common component of many approaches. Harrison and Wood look at the potential of targeted practice of prosodic awareness as an adjunct to existing literacy teaching approaches, and consider what theoretical and pedagogical questions we need to address in order to understand the efficacy of such an approach.

The last two chapters of this section draw heavily on speech science perspectives, in order to examine the neurological underpinnings of linguistic rhythm

perception. **Thomson** (Chapter 5) provides an overview of the neural pathways that take as their input basic acoustic features of the speech signal. These speech signals pass from the peripheral nervous system to the highest levels of conscious processing in the cortex, where they are imbued with complex linguistic meaning. Thomson explores the evidence for right hemisphere specialization in processing of suprasegmental information, and looks at questions that echo the thinking of Harrison and Wood, from a neurological perspective, specifically: Can an increased understanding of connections between rhythm and language processing have a direct impact on educational theory and practice?

Goswami and **Leong** (Chapter 6) report evidence that is potentially affirmative. Drawing on an expansive range of evidence, these authors attempt to link neural theory and behavioural phenomena using the test case of developmental dyslexia. The authors focus at the level of neural oscillations – a basic level of processing that enables event representation in the brain, including speech rhythm. Describing evidence of atypical *entrainment*, or temporal alignment of low frequency oscillations in populations with dyslexia, the authors also link this atypical entrainment to phonological processing and reading problems within the same populations, at a group level. An additional important contribution that this chapter makes is a developmental hypothesis. Working on the assumption that children's sound processing systems are being influenced by genes and the environment even in utero, the authors speculate as to how a neural oscillation disturbance, from even these earliest stages, could result in reading difficulties at school age.

The next part of the book, *Prosodic Productivity & Literacy,* focuses on oral production of prosody in typical and atypical readers. The chapter by **De Bree** and **Wijnen** (Chapter 7) continues with a developmental perspective by looking at word stress production in children with and without genetic familial risk of developmental dyslexia. The complexity of the relationships between speech rhythm, in this case lexical stress specifically, and literacy, are demonstrated by varying relationships across age: Longitudinally, the word stress production competence of 3-year-olds at family risk of dyslexia was correlated with school-age phonological awareness skills, but not reading per se. However, with a group of 8-year-old students diagnosed with dyslexia, correlational relations between word stress production and reading skills were more direct. The authors speculate that developmental links between suprasegmental processing and literacy may be bi-directional, in that while early word stress ability contributes towards phonological processing abilities, the segmentalization of speech representations that literacy brings may have a reciprocal contribution on the continued development of word stress knowledge in the acquisition of new, longer words.

Jarmulowicz's chapter (Chapter 8) stays at the lexical stress production level, but adds the intriguing perspective of derivational prosody. English is a language

in which morphological markers can be added as affixes to the end of words, to create related, new words, for example, adding '*ity*' to 'electric', to create, 'electricity'. In "non-neutral" cases like this example, a new lexical item is generated, but a stress shift also occurs that is predictable across words featuring this suffix. These types of words thus give us a unique window through which to look at how the mental representation of prosody interacts with the lexicon. Jarmulowicz examines the production of derivational morphemes across two typically developing primary school age samples, as well as a group of children with dyslexia, documenting a developmental change in error rates, as well as the presence of proportionally more syllabification differences in the group with dyslexia.

The final chapter in this section brings the study of speech rhythm and literacy to one of the most direct manifestations of this relationship – reading aloud. While reading "with expression" has often been informally used as a marker of increasing reading competency, **Schwanenflugel** and **Benjamin** describe the emergence of more objective tools and measurement to assess reading fluency. The authors demonstrate how spectrographic aspects of reading aloud can be linked to reading accuracy, fluency and comprehension, as well as describing an evaluation tool for classroom use, based upon this spectrographic evidence.

In the final part of the book, *Prosody and Orthography*, our authors look more closely at the cues that individual word forms, or the orthography of a language, offer the reader in terms of stress placement. Given that not all language have explicit visual markers for suprasegmental features such as stress, **Monaghan**, **Arciuli** and **Seva** (Chapter 10) analysed corpora of English, Dutch, German, Italian, Spanish, and Greek polysyllables, to examine whether stress can be predicted from alternative sublexical cues, such as letter sequences at the beginning or end of a word. The authors find that although the specific nature of the cues vary across languages, sublexical information can indeed predict stress placement with high accuracy.

This finding is a critical piece of evidence in the question of how suprasegmental information is represented cognitively. Monaghan et al.'s findings suggest the stress placement may not be an exclusively lexical operation. **Protopapas** (Chapter 11) provides contrasting evidence from the Greek language. Greek is a rare language that provides reliable diacritic cues to stress in its written form; however, it is also a 'free-stress' language where stress placement is not always phonological predictable. Given the unpredictable nature of stress placement and the 'solution' provided by diacritics, one would hypothesize that sublexical diacritics would be highly attended to in word reading. Evidence across emerging readers, children with dyslexia and adult readers with established reading skills does not support this supposition, however. Readers appear to be relying on lexical-item-specific processing strategies, with diacritics bearing little information value.

The final chapter of this section, by **Gutiérrez-Palma**, **Defior** and **Calet** (Chapter 12) is a fitting end to both the section and the book. Like Greek, the Spanish orthography marks stress with diacritics and in a language where the stress is only partly free, more consistent relationships between lexical stress perception and lexical stress marking in reading and spelling have been found. Gutierrez-Palma et al.'s chapter offers a replicable roadmap for the investigation of speech rhythm within a specific language system. Their map starts with identifying language-specific properties of spoken and written prosody. This leads to the design of assessment tools that can assess both perception and production of these features and finally, once relationships are preliminarily understood, the application of this knowledge is investigated, for example, through intervention studies.

Concluding Remarks

An overarching aim of this volume is to showcase recent empirical research exploring the association between rhythm and reading. Understanding this association cannot be accomplished by one discipline alone and by presenting current areas of convergence and discrepancy here, we hope to inspire the next generation of knowledge.

There is still much we can learn from each other, especially with respect to methods and levels of investigation. These two areas are not entirely separable, nor should they be. Methods typically fall out of a particular theoretical perspective, and methods limit what can be tested. It thus becomes all the more important for those studying prosody to be very clear about what level of the system is being examined, what assumptions are inherent in the methods, and how the results may or may not be similar to the work of others. As the research matures, the nuances matter more. In order for the research to hone in on the relationships between prosody and literacy, future researchers must understand each other. This is perhaps one of the biggest challenges ahead.

References

Blevins, J. (1995). The syllable in phonological theory. In J. A. Goldsmith (Ed.), *The handbook of phonological theory*. Cambridge, MA: Blackwell.

Halle, M., & Vernaud, J.-R. (1987). *An essay on stress*. Cambridge, MA: The MIT Press.

Hayes, B. (1995). *Metrical stress theory: Principles and case studies*. Chicago, IL: Chicago University Press.

Grabe, E., & Low, E. L. (2002). Durational variability in speech and the rhythm class hypothesis. *Papers in Laboratory Phonology*, *7*, 515–546.

Jarmulowicz, L., & Taran, V. L. (2007). Exploration of lexical-semantic factors affecting stress production in derived words. *Language, Speech, and Hearing Services in Schools*, *38*, 378–389. doi:10.1044/0161-1461(2007/039)

Ladd, D. R. (2008). *Intonational phonology*. Cambridge, UK: Cambridge University Press. doi:10.1017/CBO9780511808814

National Reading Panel (US), National Institute of Child Health, & Human Development (US). (2000). Report of the national reading panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction: Reports of the subgroups. National Institute of Child Health and Human Development, National Institutes of Health.

Selkirk, E. O. (1980). The role of prosodic categories in English word stress. *Linguistic Inquiry*, *11*, 563–605.

Shriberg, L. D. (1993). Four new speech and prosody-voice measures for genetics research and other studies in developmental phonological disorders. *Journal of Speech and Hearing Research*, *36*, 105–140. doi:10.1044/jshr.3601.105

Shriberg, L. D., & Kent, R. D. (2003). *Clinical phonetics* (3rd ed.). Boston, MA: Allyn & Bacon.

SECTION I

Prosodic Sensitivity & Literacy

CHAPTER 1

The Contributions of Prosodic and Phonological Awareness to Reading

A Review

Lesly Wade-Woolley & Lindsay Heggie
University of South Carolina, USA / Queen's University at Kingston, Canada

This chapter sets out both the theoretical and empirical evidence for considering traditional phonological awareness and prosodic awareness as constructs that play independent roles in explaining reading skill. A general linguistic description of phonological awareness and prosody are provided, and the ways in which segmental and suprasegmental phonology work together are discussed. Ten empirical studies are then examined, where a variety of phonological awareness and prosodic awareness measures were used to predict different reading outcomes. Based on a synthesis of these findings, it is concluded that prosodic awareness makes a consistent additional contribution to reading that is independent of traditional measures of phonological awareness.

Introduction

There is a certain linguistic intricacy that young readers face as they become more skilled, regularly encountering words that extend beyond three and four syllables, and as phrases and sentences become increasingly syntactically complex. The texts that they read become more and more similar to the dynamic language they hear spoken around them, with its shades of meaning and references to information outside that which is stated explicitly. Learning to read is based in large part on a foundation of oral language, and we are able to make connections to meaning in written language thanks to our ability to understand and engage with spoken language. This chapter, like the rest of this text, focuses on one particular aspect of oral language that appears to be implicated in reading: prosody.

DOI 10.1075/tilar.17.01wad

Prosody operates at different phonological levels and can therefore be implicated in reading in a variety of ways. When it operates at the level of the word, it can change the grammatical category of a lexical item from a verb to a noun, or it can change the meaning of a word entirely. Because prosody is a key component of language, and because literacy is rooted in language, it is sensible to investigate prosody's role in literacy. We echo the assertion of Hirotani, Frazier, and Rayner (2006): "That reading should be parasitic on the mechanisms underlying the comprehension of the spoken language should not surprise us. What would be shocking is if the rich structuring provided by the intonational system could simply be set aside during reading" (p. 439–440).

A challenge arises, however, when we come to integrate prosody into our existing models of reading, not least because there are several possible ways in which prosody contributes to reading (Wood, Wade-Woolley & Holliman, 2009). For example, reviewers of studies that investigate the role of prosodic awareness in word reading have often been doubtful about whether prosody is really anything different from traditional phonological awareness. Such skepticism is perhaps understandable when we consider the research demonstrating that different measures of phonological awareness tap what is fundamentally the same construct (Anthony, Lonigan, Driscoll, Phillips & Burgess, 2003; Stanovich, Cunningham & Cramer, 1984; Yopp, 1988). Perhaps prosody is yet another measure of this same construct and we are only adding unnecessary complexity to the model by calling it something else. If this is true, and the relationship that we observe between the prosody measures and reading measures is essentially the same one we see between phonological awareness and reading, then prosody may not be a useful thing to measure. But if it *is* different, we suggest that it behooves us to assess and understand the sources of individual differences, and build it into our models of reading.

The goal of this chapter, therefore, is to show that there are theoretical and empirical reasons to consider traditional phonological awareness and prosodic awareness as constructs that play independent roles in explaining reading skill. We begin by providing a general linguistic description of phonological awareness and prosody, and discuss how segmental and suprasegmental phonology work together. We then examine ten empirical studies where a variety of phonological awareness and prosodic awareness measures were used to predict different reading outcomes. Based on a synthesis of these findings, we conclude that prosodic awareness makes a consistent additional contribution to reading that is independent of traditional measures of phonological awareness. Finally, we discuss how we might consider framing these constructs in our theories of reading.

Phonological awareness

One of the strongest oral language predictors of our success as readers – and one of the most heavily researched areas in beginning reading – is phonological awareness. Phonological awareness refers to the understanding that words are made up of smaller sound units, a foundational concept for decoding words using the alphabetic principle when learning to read. In the reading literature, phonological awareness is most commonly referred to as an umbrella term incorporating the awareness of, and ability to orally manipulate, the component sounds of words: the syllables, the onset-rime units, and most critically, the phonemes. Phoneme awareness is the last of these skills to be acquired, because as the smallest sound units of language phonemes are also the most challenging for children; as a result, phoneme awareness has been the focus of a substantial amount of work in the developmental reading literature in the last several decades, with powerful and far-reaching results for reading theory (Adams, 1990; Goswami & Bryant, 1990; Ehri, Nunes, Willows, Schuster, Yaghoub-Zadeh & Shanahan, 2001; National Institute of Child Health and Human Development (NICHHD), 2000; Snow, Burns & Griffin, 1998).

Research has explored many different ways to measure phonological awareness. Typical assessment activities require participants to segment, blend or delete various sound units within words. Although some assessments require conscious manipulation of entire syllables, these are relatively few; because children reach ceiling on this type of task fairly early, such tasks fail to elicit any variability. Early investigations of phonological awareness (Bruce, 1964) approached speech sounds as linear strings, consisting of initial, medial and final phonemes (e.g., mitt /m/ /I/ /t/); it is now more common, however, to view the syllable as containing an internal hierarchy, structured to contain as a first division the onset and rime (e.g., /m/ – /It/). The rime is then subdivided further into an obligatory vowel nucleus (e.g., /I/) and an optional coda (e.g., /t/). In English, the onset and rime may be constituted by multiple phonemes. Therefore, in current usage, we may use the term phonological awareness to apply generally to the ability to reflect on, and manipulate, the sounds of oral language at the level of onset and rime, or at the deeper level of individual phonemes. It is important to note that the scope of these phonological awareness activities is invariably applied to phonological *segments* within a single syllable, often a monosyllabic word. Thus, phonological awareness, as it operates upon consonants and vowels, may be said to belong almost exclusively to the realm of segmental phonology.

Despite the strength of its relationship with reading, phonological awareness is not the only explanatory factor in reading development, as studies utilizing

letter-sound knowledge, rapid naming speed, and phonological working memory have shown (Wagner & Torgesen, 1987). Furthermore, the contribution of phonological awareness to reading may be developmentally limited (Griffiths, 1991; Stanovich, 1986), reaching a point at which it no longer explains individual differences in reading skill despite maintaining a reliable predictive relationship in the elementary grades (Parrila, Kirby & McQuarrie, 2004; Wagner et al., 1997). Researchers continue to explore factors that add explanatory value to models of reading development, and in recent years there has been increased activity around the relationship of prosodic awareness to reading.

Prosody and prosodic awareness

Prosody has been called the "rhythm and melody of spoken language" (Speer & Ito, 2009, p. 90) and the "organizational structure" of speech (Beckman, 1996, p. 19), manifested through patterns of linguistic rhythm, pitch and emphasis. Prosody is applied at different levels of speech, from the alternation of strong and weak syllables across an utterance (e.g., *JOsie MARveled at the disPLAY of TAsty DELicacies,* where upper case letters represent stressed syllables) to primary stress on a syllable within a single word (e.g., *inDUStrial*). At the utterance level, it can convey collocation of elements or prominence of some discourse element (e.g., *Would you like some coffee? I would LOVE some.*). Stressed syllables create a distinct rhythm over an utterance, and their distribution also plays an important role in meaning. For example, word pairs like *DEsert* (arid, sandy) and *deSSERT* (sweet, chocolate), which differ phonologically only in their stress placement but hold entirely different meanings, and noun-verb pairs such as *REcord* (7" vinyl; noun) and *reCORD* (digitally encode for playback; verb), which are semantically related but differ in stress placement to distinguish grammatical category. Because of this semantic connection, the stress pattern of English words remains relatively invariable between speakers, despite the fact that stress is not overtly marked in the orthography as it is in some languages (e.g., Spanish, Greek). The acoustic correlates of stress are duration, amplitude and frequency; stressed syllables tend to be longer, louder and pitched higher than are unstressed syllables. Prosody, along with tone in tonal languages, is suprasegmental; it is associated with segmental elements like consonants and vowels, but it is distinct.

Assessment of prosodic awareness has proven challenging, but reading researchers have managed to find creative ways to isolate this suprasegmental element of oral language in order to assess its relationship to reading. The focus of these tasks ranges from the phrase level to the word level. For example, Wood and

Terrell (1998) asked participants to make same-different judgments on low-pass filtered spoken sentences. Low-pass filtering removes high frequency information from the speech signal, giving the perceptual effect of removing the phonemic content but preserving the intonation contour. Wade-Woolley, Austin, and Chan (2012) presented participants with a multisyllabic word and asked them to identify the syllable that held primary stress, then to say the word as it would be pronounced if primary stress moved one syllable to the right (e.g., SOlitary becomes soLItary). Other prosodic awareness tasks exploit the interaction of morphology with phonology, as Jarmulowicz and colleagues did by asking participants to manipulate stress-shifting derivational suffixes to form new words (Jarmulowicz, Taran, & Hay, 2007). In a subsequent section of the chapter, we will examine whether these methodological differences have a systematic effect on the relationship between phonological awareness, prosodic awareness and reading.

Segmental and suprasegmental phonology

We have mentioned segmental and suprasegmental phonological information, but how do the two relate? In this section we draw from a theoretical description that has its roots in linguistics to clarify the relationship between the segmental and suprasegmental. Although the precise articulation of phonological theories are always under refinement by linguists, the intricacies of such theories are less important for our purposes than some of the general conceptual outlines of how levels of phonological information work together, and how these representational systems are related to reading. In particular, we refer to some of the general principles of metrical phonology (Goldsmith, 1990; Halle & Vergnaud, 1987; Hayes, 1995; Prince, 1983), a theory originally developed to deal with suprasegmental information. Stress is only one aspect of the suprasegmental information that is encoded in phonological representation, although it is a very important one for English. Tone, vowel harmony and consonant harmony are other suprasegmental elements that are important for other languages. Under metrical phonology, stress is not a collection of features as consonants and vowels are, but is instead a hierarchical organization of speech rhythm that projects relative prominence at each successive level. Stress prominence can be portrayed in a grid format like the one in Table 1 (note that the most prominent stress is marked by the larger Xs).

The lowest tier of the grid (Syllable level) marks the rhythmic pattern of every syllable, while the second tier marks those syllables grouped into feet (Foot level), which are binary units of strong and weak syllables. The grid projects upwards from the strong syllable within each foot. For example, the word *Manitobans*

Table 1. Metrical grid of stress prominence

Phrase level									x	
Word level			x		X				x	
Foot level	x		x		X		x		x	
Syllable level	x	x	x	x	X	x	x	x	x	x
	su	per	sti	tious	sin	ful	Man	i	to	bans
		Superstitious			sinful			Manitobans		

contains four syllables and two feet. Feet themselves are relatively strong and weak, and strong feet project to the next level of the phonological word (Word level). For example, the word *superstitious* projects stress from its third syllable up to the level of the phonological word. Phrase level stress in English is usually projected from the most prominent syllable in the phrase head, which in English is typically the right-most word; in our example, the third syllable of *Manitobans* projects to the phrase level.

There are several useful insights for reading researchers within the notion that stress operates hierarchically and at a suprasegmental level above the segmental tier of consonants and vowels. First, it provides a unitary understanding of how stress is manifested within the individual word as well as across words at the phrasal level. Second, stress information becomes an obligatory part of every phonological word (content words, but not function words, are considered phonological words, because function words do not bear stress). Monosyllabic words bear stress, but multisyllabic words have a fairly predictable concatenation of stressed and unstressed syllables. When we consider phonological awareness in light of these insights, it becomes clear that the scope of traditional phonological awareness activities is restricted to a small aspect of the overall phonological representation. Phoneme and onset-rime awareness operate on segments within the realm of the syllable, which we have seen is the lowest tier of the prosodic hierarchy. It is clear how phonological awareness sets the stage for children to crack the code of alphabetic orthographies and become successful decoders, since consonant and vowel letters map onto consonants and vowels in spoken language. The scope of phonological awareness activities, however, extends beyond the segmental level to encompass the suprasegmental level. Since children who are learning to read English are expected to read multisyllabic words from an early age, it is reasonable to expect that awareness of suprasegmental phonology would make a contribution to reading as well. In the following sections of the chapter, we examine a number of research reports that have tested the contributions of both segmental and suprasegmental phonology to reading, in order to determine whether empirical evidence supports our theoretical argument.

Search Strategy

In order to locate the published, peer-reviewed journal articles exploring prosody's role in reading development beyond the influence of phonological awareness, we conducted a search of the literature focusing on three databases: PsycINFO, Academic Search Complete, and Education Resources Information Center (ERIC). We began by conducting three separate searches on prosody, phonological awareness, and reading in these three databases. We limited our search to studies published in English, but did not restrict the languages studied. Dissertations were not eligible for inclusion.

To cast as wide and comprehensive a net as possible, we searched for papers using any terms that may be used to refer to the three overarching subject areas: prosody, phonological awareness, and reading. This meant creating three separate search strings. For the search on prosody, we selected Linguistic Stress, Metrical Stress, Lexical Stress, Speech Rhythm, Linguistic Rhythm, Stress, Prosod* (to catch both Prosody and Prosodic), Prosodic Awareness, Prosodic Sensitivity; these search terms were combined with the Boulean operator OR. For phonological awareness, we searched for Phonological Awareness, Phonolog* (Phonology and Phonological), Phonological Sensitivity, Phonemic Awareness, Phonemic Sensitivity, Phonem* (Phoneme and Phonemic), Phoneme Awareness, Phoneme Sensitivity, Onset-Rime Awareness, Onset-Rime Sensitivity, Syllable Awareness, Syllable Sensitivity, Syllab*, OR Onset-Rime. For reading, we searched for Reading, Word Reading, Decoding, Word Recognition, OR Reading Comprehension. The three searches were conducted on Title and Abstract in each database and then combined (i.e., Prosody AND Phonological Awareness AND Reading, including all search terms in each subject area).

When we combined the search results from these three databases, a total of 521 articles were imported into RefWorks. After searching for exact duplicates, 108 references were deleted, leaving a total of 413 articles. These were then manually scanned by title and abstract to remove missed duplicates and irrelevant articles, leaving 16 articles relevant to our question. We then obtained the full text copy of these 16 and performed a manual scan of the full text to identify research reports that could be used in the current synthesis.

Studies eligible for synthesis reported regression analyses where both phonological awareness and some aspect of prosodic awareness were included as predictors of reading, with the final beta coefficients reported. Such a model allows the reader to ascertain the relative strength of the independent variables to the dependent variable once all of the variables are included in the equation. In a hierarchical regression, the beta weight of a variable entered in the first step may reduce as subsequent variables are entered; this is expected when the relationship between

the independent variables are correlated to some degree, as they normally are with phonological and prosodic awareness. In the studies identified for this paper, the mean reported correlation coefficient between these two constructs was .48. Beta weights can be compared only within samples, as they are affected by the variances of the dependent and independent variables, and thus may differ across studies (Kline, 2011). Therefore, although we may not directly compare the relative strength of these constructs across studies, we may investigate the prevalent patterns of relationship within studies to ascertain whether prosodic awareness makes a unique contribution to reading after the contribution made by phonological awareness, thus providing some empirical evidence that prosodic awareness is not isomorphic with traditional measures of phonological awareness.

Based on these criteria, ten of the 16 articles were found to be relevant for inclusion in our analysis. The range of eligible studies reported on reading and prosody processing in English and Spanish, and included participants ranging from five to 15 years of age. A number of studies that we anticipated would be included did not meet the criteria for various reasons. For example, Wood and Terrell (1998) conducted no regression analysis and Wood (2006) reported only initial rather than final beta weights. Gutiérrez-Palma and Palma-Reyes (2007) did not have a measure of phonological awareness and Beattie and Manis (2014) did not include a reading outcome.

Included Articles

Before delving more deeply into the details of each included article, it is helpful to first provide an overview of the ten. In this section, we will describe them in chronological publication order.

Whalley and Hansen (2006) explored the relationship between children's (M_{age} = 9 years, 3 months) prosodic skills and their reading ability (word reading and reading comprehension). Prosodic skills at the word and phrase level were found to make a unique contribution to reading ability, after controlling for phonological awareness and other variables; children's word-level prosodic awareness predicted unique variation in word reading and in reading comprehension, while phrase-level prosodic skills predicted unique variance in reading comprehension only.

Jarmulowicz, Taran, and Hay (2007) examined the relationship between third grade children's (M_{age} = 8 years, 10 months) metalinguistic skills (phonological and morphological awareness), their reading skills (word reading and pseudoword reading), and their ability to accurately stress derived words constructed either with stress-shifting (e.g., *-tion*) or stress-neutral (e.g., *-ment*) suffixes. Accurate

stress production on derived words explained a significant amount of variance in decoding after both phonological and morphological awareness (as well as age and expressive/receptive language) were controlled; this pattern was also true when stress production was the outcome variable, showing a strong bidirectional relationship.

Holliman, Wood, and Sheehy (2008) investigated whether an awareness of prosody predicted variance in younger children's reading. Participants (M_{age} = 6 years, 1 month) completed measures of phonological awareness (rhyme detection, phoneme deletion), reading, and prosodic manipulation (at the word level); results indicated that children's prosodic awareness accounted for a significant amount of variance above and beyond the influence of age, vocabulary, and PA.

Gutiérrez-Palma, Raya-García, and Palma-Reyes (2009) explored whether the word-level prosodic skills of Spanish-speaking children (M_{age} = 7 years, 8 months) facilitated word level stress acquisition and predicted reading performance. Although students' sensitivity to lexical stress was not related to their word reading skills, it did predict unique variance in connected text reading, even after accounting for phonological awareness.

The relationships between prosodic awareness (word level stress), morphological awareness, and reading ability were examined in a population of school-aged children between the ages of 8 and 13 (Clin, Wade-Woolley, & Heggie, 2009). Students had significantly more difficulty producing derivational suffixes involving a stress change (i.e., Stress-Change and Stress-and-Phonemic-Change suffixes) than with those involving no change or a phonemic change only. Further, after controlling for age, verbal and nonverbal abilities, and phonological awareness, prosodic awareness and morphological awareness were each significant predictors of reading ability.

Several of the included articles were published in 2010, including the article with the youngest population of students in our sample. Goodman, Libenson, and Wade-Woolley (2010) investigated the role of prosodic awareness, at the word and phrase level, in the phonological awareness and reading development of young children (M_{age} = 5 years, 6 months). Word and phrase level stress were not significantly correlated, but together they accounted for 28% of the variance in phonological awareness. Word level prosodic awareness was significantly related to phonological awareness and early reading ability, but it was not a unique predictor of early reading beyond the influence of phonological awareness.

A cross-sectional study of children (M_{age} = 6 years, 6 months) explored the extent to which speech rhythm (word level prosody), non-speech rhythm, and literacy skills are interrelated (Holliman, Wood, & Sheehy, 2010a). Results showed that both prosodic awareness and receptive non-speech rhythm (rhythm matching) accounted for unique variance in literacy skills, above and beyond the

influence of age, vocabulary, PA, short-term memory, and each other (that is, non-speech or speech rhythm, respectively).

A follow-up study by the same authors investigated whether prosodic awareness would predict unique variance in word reading and reading fluency one year later (at M_{age} = 7 years, 7 months) (Holliman, Wood, & Sheehy, 2010b). After controlling for age, vocabulary, and PA, prosodic awareness at the word level emerged as a significant predictor of both word reading and the phrasing component (defined as stress, intonation, and expression) of reading fluency, measured at Time 2.

Also in 2010, Goswami, Gerson, and Astruc explored the relations between auditory perception of amplitude envelope structure, prosodic awareness, and phonological awareness. They compared the performance of children with dyslexia (M_{age} = 12 years, 1 month) to that of typically developing children in age-level matched (M_{age} = 12 years) and reading-level matched (M_{age} = 9 years, 3 months) control groups. In regression analyses with only the age-matched groups treated together, prosodic awareness (at the phrase level) and phonological awareness each made independent or overlapping contributions to reading and spelling outcomes when rhyme awareness was the measure of phonological awareness. This pattern did not hold, however, when phoneme awareness was used as the measure of phonological awareness; the authors surmised that phoneme awareness and prosodic awareness likely shared a greater degree of overlapping variance. Since the analyses were not undertaken for typical and poor readers separately, the study sheds no light on how phonological and prosodic awareness predict reading as a function of reading ability.

Finally, Defior, Gutiérrez-Palma, and Cano-Marín (2012) examined the potential role of prosodic skills in both reading and spelling development in Spanish-speaking students (M_{age} = 10 years, 9 months). After controlling for short-term memory and phonological awareness, word level stress awareness partially explained both reading and spelling performance. Phonological awareness, however, explains only a small percentage of variance in spelling, and is not a significant predictor of reading; the authors suggest that as phonological awareness's influence wanes, prosodic skills become increasingly relevant in the more advanced stages of reading and spelling, including reading fluency.

Although some of the studies included spelling outcomes (Defior et al., 2012; Goswami et al., 2010), or outcomes around reading with expression (Holliman et al., 2010b), in this paper we considered only word reading, reading comprehension, and nonword reading outcomes. We evaluated the studies in terms of the types of dependent and independent measures used to gain an understanding of the scope of constructs included in this body of research. In what follows, we classify and synthesize the findings of the studies to determine the interrelationships of prosodic awareness, phonological awareness, and reading.

Reading measures

The reading outcome measures that were employed in these studies included primarily standardized measures of word reading, nonword reading, text or sentence level comprehension, and composite variables comprised of several reading scores. In some cases (Defior et al., 2012; Holliman et al., 2008), experimental measures were used. Although ten research reports were examined, several of these included more than one reading measure, and we consider the multiple reading outcomes separately here in order to ascertain whether relationships between prosody, phonological awareness, and reading differ as a function of the type of reading skill assessed. Seven studies used measures of isolated word reading as criterion variables (see Table 2). Of these, five studies found that prosodic awareness was a unique predictor in the equation after the introduction of phonological awareness. Three studies used nonword reading as the dependent variable in regression equations, but only one of these reported that prosodic awareness was a significant predictor after phonological awareness. Five studies used reading comprehension, at the text or sentence level, as the dependent variable. Of these, four showed the expected relationship. Finally, two studies used a reading composite as the dependent variable, in which the construct was either created by combining word reading and nonword reading scores (Holliman et al., 2008) or by combining word reading, nonword reading and reading comprehension scores (Clin et al., 2009). Both of these studies report prosodic awareness as a unique predictor of the reading construct after phonological awareness. Overall, the evidence suggests that prosodic awareness does make a contribution to reading that is not the same as that given by phonological awareness. It is notable, however, that this trend is less strong for nonword reading, in which only of three studies showed the expected relationship. This could be because nonwords do not generally have a "correct" way to assign stress; some standardized reading tests accept responses with the stress placed on different syllables. (Note that is not the case for Jarmulowicz et al. (2007), since the derivational suffix used in the task was meant to generate a response with a specific stress pattern, even though the item was a nonword.)

Phonological awareness measures

It is possible that prosodic awareness tasks make a contribution to reading only in the presence of particular phonological awareness tasks. Therefore, we inspected the eligible studies with respect to how phonological awareness was measured and whether small (phoneme) or large (rime) units were the subject of phonological analysis. The phonological awareness measures used in the ten studies employed a variety of paradigms that tap segmental phonology at both rime

Table 2. Results of regression analyses organized by type of reading outcome

Reading outcome	Study and mean age of participants	Prosody predicts after PA in regression model?
Word reading	Holliman et al. (2010a), mean age 6:6	Yes (BAS)
	Holliman et al. (2010b); mean age 7:7	Yes (BAS)
	Whalley & Hansen (2006); mean age 9:3	Yes (Word ID)
	Goswami et al. (2010), mean age 12:7	Yes (BAS, TOWRE)
	Defior et al. (2012), mean age 10:9	Yes (experimental Spanish reading test)
	Guttiérez-Palma et al. (2009), mean age 7:6	No (standardized Spanish test)
	Goodman et al. (2010), mean age 5:7	No (composite of Word ID and WRAT)
Nonword reading	Jarmulowicz et al. (2007), mean age 8:8	Yes (Word Attack)
	Whalley & Hansen (2006), mean age 9:3	No (Word Attack)
	Guttiérez-Palma et al. (2009), mean age 7:6	No (standardized Spanish test)
Reading comprehension	Whalley & Hansen (2006); mean age 9:3	Yes (NARA)
	Guttiérez-Palma et al. (2009), mean age 7:6	Yes (standardized Spanish test)
	Defior et al. (2012), mean age 10:9	Yes (standardized Spanish test)
	Holliman et al. (2010b), mean age 7:7	No (NARA)
Composite of word reading and reading comprehension	Holliman et al. (2008), mean age 6:1	Yes (BAS, experimental nonword reading task)
	Clin et al. (2009), mean age 10:6	Yes (GORT, Word ID, Word Attack, TOWRE Words, TOWRE Nonwords)

NOTE: BAS: British Ability Scales; Word ID: Word Identification subtest of Woodcock Reading Mastery Test – Revised; Word Attack: Word Attack subtest of the Woodcock Reading Mastery Test – Revised; TOWRE Words: Sight Word Efficiency subtest of the Test of Word Reading Efficiency; TOWRE Nonwords: Phonetic Decoding Efficiency of the Test of Word Reading Efficiency; WRAT: Wide Range Achievement Test; NARA: Neale Analysis of Reading Ability; GORT: Gray Oral Reading Test.

NOTE: mean age represented by years:months

and phoneme level (see Table 3). Five of the ten studies (Goswami et al., 2010; Holliman et al., 2008, 2010a, 2010b; Whalley & Hansen, 2006) incorporated both levels of phonological awareness in their regression models, either as individual variables entered separately into the equation or as part of a composite phonological awareness factor. Nine regression equations were reported in these five studies, and in seven of these, prosodic awareness survived control for phonological awareness. Because only one study (Defior et al., 2012) used only a rime-level task to represent the phonological awareness construct, it is difficult to draw broad conclusions about the relationship of rime awareness and prosodic awareness to reading. It is notable, however, that in this single study, prosodic awareness survived control of rime awareness in both word reading and reading comprehension. Of the six regression analyses in the four studies (Clin et al., 2009; Goodman et al., 2010; Gutiérrez-Palma et al., 2009; Jarmulowicz et al., 2007) where phonological awareness was represented only by a phoneme-level measure, four showed prosodic awareness was an independent predictor of reading.

Table 3. Results of regression analyses organized by level of phonological awareness

Level of phonological awareness measured	Study and type of phonological awareness task	Prosody predicts after PA in regression model?
Rime level only	Defior et al. (2012) rime oddity	Yes (word reading) Yes (reading comprehension)
Phoneme level only	Goodman et al. (2010) phoneme deletion, phoneme blending	No (word reading)
	Clin et al. (2009) phoneme deletion	Yes (reading composite)
	Jarmulowicz et al. (2007) phoneme deletion, phoneme blending	Yes (word attack)
	Gutiérrez-Palma et al. (2009) phoneme segmentation, phoneme deletion, phoneme oddity	No (word reading) No (nonword reading) Yes (text reading)
Combined rime and phoneme	Holliman et al. (2008) rime detection, phoneme deletion	Yes (reading composite)
	Holliman et al. (2010a) rime detection, phoneme deletion	Yes (word reading)
	Holliman et al. (2010b) rime detection, phoneme deletion	Yes (word reading) No (text reading)
	Goswami et al. (2010) rime oddity, phoneme oddity	Yes (word reading) Yes (word reading speeded)
	Whalley & Hansen (2006) rime oddity, phoneme oddity	Yes (word reading) No (nonword reading) Yes (reading comprehension)

In addition to drawing on different levels of phonological awareness in explanatory models, researchers have relied on different ways to assess phonological awareness. Detection tasks, where the object is to identify the appropriate word from an array, were used in three studies. Oddity tasks, where the object is to identify the word that is the odd one out, were used in six studies. Seven studies required participants to delete phonemes and say the word that remained, and two studies required participants to blend phonemes together to make a word. A single study asked participants to segment the phonemes in a word. Across these assessment methods, no clear evidence emerged that the type of phonological awareness assessment had any impact on the ability of prosodic awareness was differentially related toto predict reading in regression models.

Prosody measures

The ten eligible studies used a variety of prosodic awareness tasks. In this section, we sought to determine whether the type of prosodic awareness task affected whether it survived controls for phonological awareness (see Table 4). The majority of the tasks outlined here assess prosodic awareness at the level of word stress, yet there are key differences among them. For example, some tasks use real words or phrases that have been manipulated or require a manipulation or a judgment on the part of the participant. Knowledge of a real word may serve as a reference point in completing the task. Other tasks use nonwords, which provide less scaffolding for the participant. Gutiérrez-Palma et al. (2009) employed a measure developed by Dupoux, Peperkamp and Sebastian-Galles (2001) in which participants were trained to associate two spoken nonwords with computer keys, and then asked to reproduce presentation sequences ranging from two to four items using a keypress response. In one condition, the items were minimal pairs of nonwords differing by one phoneme (e.g., KUti – KUpi); in the key condition, the nonwords differed only by stress placement (e.g., miPA – MIpa). Defior et al. (2012) asked participants to listen to three-syllable nonwords that varied in stress placement and, for each item, to mark the location of primary stress by selecting one of three boxes. In the study by Jarmulowicz et al. (2007), participants were given pseudoword stems and asked to pronounce the words with the addition of stress-shifting derivational suffixes. Lexical status of the stimuli does not seem to influence how prosodic awareness relates to reading, since the outcomes are mixed. Prosodic awareness explains variance in text but not word reading in Gutiérrez-Palma et al. (2009); a similar result was found for nonword reading in Jarmulowicz et al. (2007) but this result was not reflected in Gutiérrez-Palma et al. (2009).

Another dimension of difference between tasks is the degree to which they require explicit, conscious awareness and manipulation of prosodic information.