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Iconic Prosody in Story Reading

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Abstract

Recent experiments have shown that people iconically modulate their prosody corresponding with the meaning of their utterance (e.g., Shintel et al., 2006). This article reports findings from a story reading task that expands the investigation of iconic prosody to abstract meanings in addition to concrete ones. Participants read stories that contrasted along concrete and abstract semantic dimensions of speed (e.g., a fast drive, slow career progress) and size (e.g., a small grasshopper, an important contract). Participants read fast stories at a faster rate than slow stories, and big stories with a lower pitch than small stories. The effect of speed was distributed across the stories, including portions that were identical across stories, whereas the size effect was localized to size-related words. Overall, these findings enrich the documentation of iconicity in spoken language and bear on our understanding of the relationship between gesture and speech.

Keywords: Prosody; Vocal gesture; Speech production; Iconicity

1. Introduction

As people talk, they commonly use their hands to produce iconic gestures that are related to the meaning they are expressing verbally (Kendon, 2004; McNeill, 1992). Typically, the iconic forms of these gestures are understood to reflect some more-or-less detailed aspect of the sensorimotor imagery that is associated with the meaning of the spoken utterance. For example, consider the utterance of mycologist David Arora, in which he describes the “long nice stem” of a particular variety of mushroom (http://www.youtube.com/watch?v=VSn3aGGzG1M, beginning at 4 minutes and 28 seconds). As the speaker articulates the word “long,” he simultaneously depicts the stem with his hands, curling the fingers of his right hand and tracing the stem’s length downward from his raised left palm.

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Notably, in this example, Arora also appears to depict the image of the long stem through the dynamic "shape" of his voice. In coordination with the manual gesture, he saliently extends the spoken duration of the adjective "long," stretching the word in iconic reflection of the stem's length. This observation suggests that the conceptualization of length—in this case instantiated in the context of a mushroom stem—can be iconically realized not just in co-speech manual gestures, but also in iconic modulations of the temporal patterning of speech.

Recent experimental studies show that the use of iconic prosody is not just limited to isolated instances in association with manual iconic gestures. For example, in the laboratory, English speakers have been shown to reliably produce iconic modulations of their speech rate when describing the speed of an event, and in their pitch when describing the vertical movement of an object (Perlman, 2010; Shintel, Nusbaum, & Okrent, 2006). These studies show a motivated relationship between the meaning that people are expressing and the prosodic forms that they produce in their speech. Specifically, participants tend to talk faster when describing a fast event and slower when describing a slow event. They talk with a higher pitch when referring to an object that is moving upward and a lower pitch when referring to one that is moving downward. In this paper, we refer generally to such motivated correspondences between the prosodic form of an utterance and its meaning as *iconic*, and note that iconic correspondences may be variably detailed, abstract, schematic, cross-modal, metaphoric, metonymic, etc. (Similar general usage is recognized in the manual gesture literature, for example, Cienki & Müller, 2008; McNeill, 2005).

To date, research on iconic prosody is largely exploratory. It has been investigated in just a small set of semantic domains, with the application of only a few methods and analyses. Remarkably little is known about how speakers use iconic prosody in the wild. Yet this research is significant as it contributes to the growing documentation of the prevalence of iconicity in spoken languages, in addition to signed. In languages across the world, iconicity is increasingly reported in phenomena like phonological or sound symbolism, phonesthemes, onomatopoeia, and ideophones (Dingemanse, 2012; Nuckolls, 1999; Perniss, Thompson, & Vigliocco, 2010). Linguists and anthropologists describe substantial iconic lexicons from Bantu languages in Africa (Childs, 1994), non-Pama-Nyungan Australian Aboriginal languages (Alpher, 2001; McGregor, 2001; Schultze-Berndt, 2001), Japanese, Korean, and Southeast Asian languages (Diffloth, 1972; Watson, 2001), Quecha languages of South America (Nuckolls, 1996), and Balto-Finnic languages (Mikone, 2001). Moreover, the iconicity in these conventional spoken forms relates to a wide range of meanings, including, for example, shape, manner of motion, texture, size, brightness, distance, psychological and mental states, and temporal aspect. These rich iconic lexicons point to more dynamic spoken iconic gestures, such as iconic prosody, in the processes of their formation (Perlman, Dale, & Lupyan, 2014).

The present study builds on previous research on iconic prosody in two primary ways. First, it provides further evidence of speed-related modulations of speech rate within a more naturalistic speaking task than that used by Shintel et al. (2006). Second, it extends the investigation of iconic prosody to the semantic domain of size. In both the speed and size domains, our results contribute finer details related to the temporal patterning of iconic prosody and the kinds of concrete and abstract meanings that may elicit it.

1.1. Iconicity in prosody

Most previous research on prosody in speech production has not examined how variables associated directly with the semantic meaning of an utterance might influence its prosodic form. Although boundaries between semantics and pragmatics may be contentious, we limit our use of "semantic" here to meanings that are overtly expressed by the words and phrases of an utterance, such as manner of motion (e.g., fast/slow), the shape of an entity (e.g., big/small), or an entity's spatial position and direction of movement (e.g., up/down). In contrast to these kinds of semantic distinctions, past research has generally focused on questions related to how prosody demarcates the syntactic structure of an utterance (e.g., Ferreira, 1993), how it directs attention through stress and pitch accent on focused elements (e.g., Levelt, Roelofs, & Meyer, 1999), and how it expresses paralinguistic information about a speaker's internal states like emotion and attitude (e.g., Bolinger, 1986; Bryant & Fox Tree, 2002; Cosmides, 1983). Overall, this large body of research shows that the prosodic form of an utterance is significantly determined and constrained by a multitude of factors, including the syntax and phonology of the utterance, as well as paralinguistic factors like the speaker's attention, emotion, and attitude. For instance, Levelt (1989, p. 180) summarizes that prosody is determined by the interactions of the phrasal organization of words to determine intonational unit boundaries, the mood and modality of the utterance to determine intonational patterns and boundary tones, and the assignment of pitch accent to focused elements. According to this view, the processes that determine prosody are not directly influenced by the conceptualization of the utterance.

However, recent results show that, under some conditions, prosody is also measurably influenced by variables relating to the semantic meaning of the utterance. One pioneering study recorded participants as they described the direction of motion of an animated dot on a computer screen, using the carrier phrase, "The dot is moving [left/right/up/down]" (Shintel et al., 2006). In a first experiment, participants were found to increase or decrease their fundamental frequency as they described an upward or downward moving dot, respectively. In a second experiment, the dot moved to the left or right, while also traveling at either a fast or a slow rate. Participants spoke faster when describing the leftward or rightward movement of fast moving dots compared to slow ones, even though the speed of the dot was incidental to the communicative task.

Another study investigated whether adults speaking in infant-directed speech would modulate the prosody of their voice as they spoke sentences relating to the antonymic pairs of meanings happy/sad, hot/cold, big/small, tall/short, yummy/yucky, and strong/weak (Nygaard, Herold, & Namy, 2009). Three speakers were shown a nonce word, like "foppick" or "tillen," for each meaning, and then instructed to say, "Can you get the [nonce word] one?" as if to an infant. Analysis revealed consistent differences along different combinations of acoustic parameters within each pair of antonyms. For example, the meaning *big* was characterized by lower pitch, longer duration, and higher intensity than *small*, while *tall* was characterized by a longer duration and greater pitch variation than *short*. These effects were generally found at the levels of both word and sentence.

Speakers also produce semantically motivated modulations of their prosody in more spontaneous contexts. Perlman (2010) asked participants to watch a series of short video clips showing fast or slow-paced events and then describe them open-endedly to an experimenter. On average, speakers spoke faster across their complete descriptions of fast events compared to slow events. In addition to these overall differences, they also produced distinct modulations in tempo when articulating adverbial phrases about speed, such as “really fast” or “very slowly.”

A different flavor of experiment asked participants to produce the vowel /a/ in a go/no-go task in response to stimuli that varied along three dimensions: shape (triangle vs. dodecagon), luminance (white vs. black), and size (small vs. large; Parise & Pavani, 2011). The study found that participants pronounced the syllable in different ways according to the stimuli, articulating it with higher intensity when responding to dodecagons compared to triangles and white shapes compared to black ones, and with a higher third formant for triangles compared to dodecagons. Size, however, was not found to have an effect on articulation.

Taken together, the results of these studies show that people have a tendency to modulate their prosody in iconic correspondence with certain meanings. Yet our empirical knowledge of iconic prosody remains extremely limited. For example, we know little about the kinds of meanings that are likely to influence prosody. We also know little about how iconic prosody manifests in an utterance, including the acoustic characteristics that are most relevant, as well as its temporal patterning.

Gesture scholars have proposed that one reason for this empirical gap may be related to the methodological challenge of studying iconic prosody (Duncan, 2003; McNeill, 2005). Whereas manual gestures are distinctly identifiable as communicative movements (Kendon, 2004), prosody is produced within the articulatory movements of conventional speech forms. The prosodic form is further determined by a host of other factors such as syntax and the speaker’s emotional, attitudinal, and attentional state. As a consequence, it can be challenging to identify and measure iconic prosody and separate it from these other variables.

2. Present study

Toward overcoming this challenge, the present article reports the results from an experiment that used a story reading task to investigate iconic prosody in the semantic domains of speed and size. Participants were recorded as they read aloud a series of short stories to a partner. One set of stories involved either fast or slow speed of movement, and the other, small or large size. We also examined whether abstract meanings might elicit iconic prosody, including stories within each set that involved abstract instantiations of the targeted semantic domain (e.g., slow progress or a big contract). We generally expected that participants would express the speed of the stories through the rate of speech, whereas size would be expressed through its intonational pattern. In particular, participants would speak with a faster articulation rate in fast stories compared to slow ones, and with a higher pitch in small stories compared to big ones. The task also allowed us to examine more precisely the dynamics of how the concepts of speed and size might be manifested in the temporal and intonational patterns of speech, for example, whether iconically faster or higher pitched speech occurs only in the immediate context of words like "fast" or "small," or whether it is dispersed more widely throughout an utterance.

Our predictions regarding speed and articulation rate were based on prior research showing that speakers sometimes produce slow or fast modulations of articulation rate when describing, respectively, a slow or fast event (Perlman, 2010; Shintel et al., 2006). Prior research also motivated our predictions regarding an iconic relationship between size and pitch, as in phenomena like size-sound symbolism (Jakobson & Waugh, 1979; Ohala, 1984; Tsur, 2006; but see Parise & Pavani, 2011). People routinely associate high-pitched sounds with small size and low-pitched sounds with large size. In one well-documented case, front vowels with high second formants (e.g., /i/) are associated with small, while back vowels with low second formants (e.g., /ɔ/) are associated with large (e.g., Sapir, 1929; and see Ultan (1978) for the prevalence of this association across the lexicons of various languages). Additionally, experimental results show that adults spontaneously modulate their pitch as an iconic expression of size when reading sentences in infant-directed speech (Nygaard et al., 2009).

2.1. Method

2.1.1. Participants

Sixty-seven undergraduate students (35 for speed, 32 for size) attending the University of California, Santa Cruz, participated in the study in exchange for course credit. All participants were self-reported native speakers of English.

2.1.2. Stimuli and design

Eight carefully matched pairs of short stories instantiating semantic contrasts of speed (fast vs. slow) and size (big vs. small) were created and formatted into Microsoft PowerPoint presentations (see Table 1). The first slide of each story presented an identifying character and title, and the story's content was contained in three subsequent slides that included an introduction, a plot, and a conclusion. Only the introduction and plot contained words explicitly referring to speed or size; the conclusions were identical between paired stories. Thus, the stories contained a set of contrasting phrases that differed between conditions, and the remaining non-contrasting, shared content that was identical between conditions.

In addition to the main semantic contrast, the target stories also varied in mapping type. Two of the four stories for each domain were concrete, concerning observable events and physical objects. For speed, this meant real movement taking place at a mea-

Table 1
Example story materials for speed contrast

Fast	Slow	Syl.	Section Label and Info
Martha	Martha		Character—not analyzed
A Rapid Run	A Sluggish Walk		Title—not analyzed
Martha is *a fast runner (4)*. She always exercises, and today she is out there	Martha is *a slow walker (4)*. She rarely exercises, but today she is out there	21	Intro—analyzed, instantiates contrast, *italic text analyzed for contrasting phrases*
She *takes off quickly (4)* through the neighborhood. *She dashes past some houses (7)* and continues toward a school. She *speeds to a near-sprint (5)* and reaches the final stretch	She *labors slowly (4)* through the neighborhood. *She struggles past some houses (7)* and continues toward a school. She *slows to a near stop (5)* but reaches the final stretch	37	Plot—analyzed, instantiates contrast, *italic text analyzed for contrasting phrases*
She is reaching the end	She is reaching the end	6	Conclusion—analyzed, does not instantiate contrast

surable rate, such as fast running versus slow walking, and for size, this meant large or small physical objects, like houses. The other two stories in each domain were abstract and concerned more abstract meanings described in terms of speed and size, such as career progress (e.g., “a fast track to success”) or the significance of an event (e.g., “a really big deal”).

Five filler stories were also created for each semantic domain. The fillers paralleled the target stories in structure but were unrelated to speed or size and also differed in meaning from each other. The target and filler stories were compiled together into PowerPoint presentations of four counterbalanced lists each for the size and speed domains. Each list contained four target stories representing the factorial combination of semantic valence (either fast vs. slow or big vs. small) and concreteness (concrete vs. abstract). These were interspersed among the domain’s five fillers, for a total of nine stories per list. A full list of stimuli appears in the Appendix. Table A1 displays stories involving speed, and Table A2 displays stories involving size.

2.1.3. Procedure

Subjects participated in the study in pairs but were scheduled independently and did not know each other. One member of the pair was assigned to a list containing speed stories, and the other to a list for size. Participants read their respective list of stories to their partner slide-by-slide via a self-paced PowerPoint presentation, which was displayed to the reader on a laptop computer. In three instances, only one participant arrived for a scheduled session. In these cases, the participant read from one of the speed lists to an undergraduate confederate.

To make the task more communicative and meaningful, participants were instructed "to be an interesting story teller" and were told that they would be answering questions about the stories their partner read to them. To help the reader gain familiarity with the story and engage with its meaning, each story was repeated twice consecutively in the presentation. The first time through participants were instructed to read the story silently, and the second time to read it aloud to their partner. After one partner read through his or her list of stories, the pair switched roles, and the new reader read his or her stories from the other domain. Participants concluded the session by filling out a post-experiment questionnaire. In total, a typical session lasted less than 25 min.

2.1.4. Analysis

The readings were recorded with a flat boundary microphone that was set on the table in front of the reader and connected to a digital recorder. The recordings were analyzed using Praat phonetic analysis software (Boersma, 2001).

For each story, the boundaries of sections and contrasting target phrases were marked in a Praat TextGrid. Disfluencies, such as false starts and repetitions, were marked and later excised from the analysis. The recorded readings (.wav file) and associated TextGrid annotations were fed into a Praat script that computed the durations and pitches of each marked interval, including both contrasting and shared phrases. Articulation rates were calculated by dividing the total number of syllables of the relevant portions by the total duration of those portions (see Appendix Tables A1 and A2 for syllable counts of story sections).

Pitch for the contrasting intervals of each story was computed as the duration-weighted average pitch of all contrasting phrases; pitch for the shared elements was a duration-weighted average of the pitches of the remaining, shared intervals. Duration-weighted averages were computed by multiplying each phrase's mean pitch by its duration, summing these products, and dividing the sum by the total duration of the phrases. In Praat, the autocorrelation algorithm for F0 measurements is sensitive to sources of noise, like accidental doubling or halving of the fundamental frequency during modal voicing, and inaccurate measurements of amodal voicing (like creaky voicing or whispering, which are inherently noisier). Due to these difficulties of accurately measuring F0, each participant's recording was analyzed twice. The first pass of the pitch tracker used the default settings on the raw recordings from each participant. This served to provide a baseline pitch for each participant, based on his or her average pitch across the whole task, which was used in the second pass of the pitch tracker to refine the settings for more accurate tracking.

For the second pass, several adjustments were made to the recording and to the default settings of Praat's pitch tracking algorithm. First, each participant's recording was low-pass filtered, with the upper bound of the pass band set at 8 semitones (2/3 octave) above the speaker's average pitch across the whole recording. This filter guarantees an absence of doubling for the upper octave of the speakers' constrained vocal range, starting at 4 semitones below their baseline pitch. The filter also removes formants, reducing the potential influence of supralaryngeal articulation on tracked F0. Further, to exclude amodal (breathy, creaky) voicing and reduce pitch halving, the Silence Threshold of Praat's pitch tracking algorithm was set to 0.075 (from a default of 0.03) and the floor of the pitch tracker window was set to 8 semitones below the speaker's previously determined baseline (Boersma, 1993).

2.2. Results and discussion

2.2.1. Speed stories

The data from one participant was discarded because of excessive disfluencies and failure to read a portion of a story, leaving 34 readers. Tables 2 and 3 show summary statistics for articulation rates and pitches of these stories.

First, a three-way repeated measures ANOVA was performed, with articulation rate as the dependent variable and semantic valence (items from fast or slow stories), concreteness (items from concrete or abstract stories), and contrast (contrasting or shared story intervals) as fixed within-subject factors. The test revealed a significant main effect for speed, $F(1, 32) = 4.24$, $p = .048$, partial $\eta^2 = .11$, but no interactions of speed with mapping or contrast. On average, participants' articulation rates were faster when reading the fast stories compared to the slow ones.

A three-way repeated measure ANOVA was also performed with pitch as the dependent variable and the same set of fixed within-subject factors. The ANOVA showed no main effect of speed and no interactions between speed and the other factors.

Table 2
Summary statistics from articulation rate data (syl/s) from speed stories

		Story Type		
Condition	Sections	Overall	Concrete Stories	Abstract Stories
Fast—Mean (*SD*)	Overall	5.00 (0.20)	4.79 (0.22)	5.20 (0.29)
	Shared phrases	4.79 (0.30)	4.63 (0.36)	4.95 (0.36)
	Contrasting phrases	5.20 (0.44)	4.95 (0.47)	5.45 (0.56)
Slow—Mean (*SD*)	Overall	4.86 (0.20)	4.58 (0.25)	5.13 (0.33)
	Shared phrases	4.67 (0.20)	4.37 (0.26)	4.97 (0.27)
	Contrasting phrases	5.04 (0.49)	4.79 (0.61)	5.29 (0.65)

Note. $n = 34$ participants.

Table 3
Summary statistics from pitch data (Hz) from speed stories

		Story Type		
Condition	Sections	Overall	Concrete Stories	Abstract Stories
Fast—Mean (*SD*)	Overall	173.13 (2.30)	171.50 (3.70)	175.21 (3.65)
	Shared phrases	170.74 (3.15)	169.31 (3.64)	172.25 (5.69)
	Contrasting phrases	175.97 (3.87)	173.80 (6.95)	178.34 (6.99)
Slow—Mean (*SD*)	Overall	172.56 (2.29)	172.49 (3.39)	172.68 (3.65)
	Shared phrases	170.82 (2.48)	171.37 (3.01)	170.33 (4.20)
	Contrasting phrases	174.36 (2.48)	173.72 (7.14)	175.18 (7.22)

Note. $n = 34$ participants.

To summarize, we predicted that participants would speak with a faster articulation rate when reading stories in the fast condition, but that their readings of fast and slow stories would not differ in terms of pitch. This prediction is supported by our data: stories in the fast condition were read aloud at a significantly faster articulation rate than stories in the corresponding slow condition, and there were no significant differences in pitch between fast and slow stories. Further, the lack of interaction between semantic valence and contrast suggests that the modulations in articulation rate are not concentrated within explicit phrases about speed, but are instead more dispersed across the story.

2.2.2. *Size stories*

Three participants were removed because of excessive disfluencies, leaving 29 speakers. Tables 4 and 5 show summary statistics of the pitches and articulation rates from these stories. Because pitch measurements expressed in Hertz are generally log-normally distributed (Johnson, 1997), Table 4 reports the *geometric* rather than *arithmetic* mean and standard deviation.

First, a three-way repeated-measures ANOVA was performed, with log-transformed pitch as the dependent variable, and semantic valence (items from big or small stories), concreteness (items from concrete or abstract stories), and contrast (contrasting or shared phrases) as fixed within-subject factors.

The three-way ANOVA revealed a significant main effect for size, $F(1, 27) = 13.70$, $p < .001$, partial $\eta^2 = .33$. There was also a significant interaction between size and contrast, $F(1, 27) = 7.22$, $p = .021$, partial $\eta^2 = .21$. Follow up *t*-tests showed that, for contrasting phrases, participants' pitches were significantly higher in the small condition compared to the big condition, $t(28) = 3.86$, $p < .001$, while for the shared phrases, there was no significant difference in pitch between big and small stories.

Next we conducted a three-way ANOVA with articulation rate as the dependent variable, and the same fixed factors as above. The results did not show a reliable main effect of size, nor an interaction with mapping type. There was, however, a significant interaction between size and contrast. Follow-up *t*-tests showed that, while the direction of difference was reversed between shared and contrasting phrases, neither shared nor contrasting phrases of size stories differed significantly in articulation rate.

Table 4
Summary statistics for pitch data (Hz) from size stories

		Story Type		
Condition	Sections	Overall	Concrete Stories	Abstract Stories
Small—Mean (*SD*)	Overall	170.92 (2.03)	173.37 (5.54)	168.51 (4.00)
	Shared phrases	172.43 (3.36)	175.78 (6.82)	169.13 (4.27)
	Contrasting phrases	169.43 (4.37)	170.98 (8.47)	167.89 (5.33)
Big—Mean (*SD*)	Overall	168.15 (2.01)	169.44 (5.92)	166.87 (4.21)
	Shared phrases	171.76 (3.27)	173.74 (6.90)	169.79 (4.43)
	Contrasting phrases	164.62 (3.61)	165.24 (7.66)	164.00 (6.42)

Note. $n = 29$ participants.

Table 5
Summary statistics for articulation rate data (syl/s) from size stories

Condition	Sections	Story Type		
		Overall	Concrete Stories	Abstract Stories
Small—Mean (*SD*)	Overall	4.94 (0.23)	4.85 (0.32)	5.02 (0.40)
	Shared phrases	5.08 (0.52)	5.02 (0.68)	5.13 (0.55)
	Contrasting phrases	4.80 (0.69)	4.68 (0.90)	4.92 (0.99)
Big—Mean (*SD*)	Overall	4.97 (0.23)	4.83 (0.21)	5.11 (0.42)
	Shared phrases	4.95 (0.55)	4.87 (0.63)	5.03 (0.68)
	Contrasting phrases	5.00 (0.43)	4.80 (0.76)	5.20 (0.44)

Note. n = 29 participants.

To summarize these results, we predicted that participants would speak with a higher pitch when reading stories in the small condition, but that their readings of small and big stories would not differ in terms of articulation rate. In support of this prediction, we found that contrasting phrases of small stories were spoken with a higher pitch than those of large stories, over both concrete and abstract instantiations of size. The shared sections of these stories did not differ across big and small stories. Thus, the pitch effect associated with big versus small was restricted to the immediate context in which the concept was mentioned and was not present in the parts of the story that were shared across conditions. For articulation rate, although we found an interaction between semantic valence and contrast, follow-up tests failed to reveal any significant pairwise differences between the contrasting or shared elements of big and small versions, indicating no systematic influence of semantic valence on articulation rate.

2.2.3. *Alternative explanations*

Although in line with our predictions, the fact that only contrasting size phrases varied in pitch presents the possible confound that the difference is an artifact of different phonological content between the conditions, rather than the contrasting meanings. (Note, however, that this cannot account for the articulation rate effect of speed stories, which occurred in the phonologically-identical shared phrases as well as contrasting ones.) There are intrinsic pitch differences associated with consonant voicing. For example, /ta/ has a higher intrinsic F0 than /da/ (Ohde, 1984), although this effect is small, short in duration, and localized to high-pitched contexts early in the utterance (Hanson, 2009). More important, vowel character is also associated with intrinsic pitch differences. For example, /bi/ has a higher intrinsic F0 than /ba/ (Whalen & Levitt, 1995). Thus, it is important to test whether the pitch effect could have been due to low-level mechanics of articulation, rather than to the semantic differences between conditions.

To address this possible confound, we reasoned that, if the phonological characteristics of contrasting phrases are responsible for the pitch differences, then phrase pairs whose phonological content biases the small member of the pair toward higher pitch should have substantially greater differences than phrase pairs whose phonological content is distributed with an opposite bias. For example, the phrase pair "itty-bitty houses" versus "gargantuan houses" should have a larger pitch difference than the pair, "a hefty price to pay" versus "a small price to pay."

This was tested by first quantifying the degree of phonological contrast along the potentially troublesome features. A phonological bias score was computed for each phrase pair as a ratio of the odds of the higher- versus lower-pitched phone types for the small phrase of each pair, versus the same odds for the big phrase of each pair (see Table 6; χ^2 tests showed no significant difference in the distribution of vowel and consonant types between small and large phrases). For voicelessness, we used the counts of voiceless and voiced consonants in the small and big phrases of each of the 13 pairs to calculate the odds ratios of voiceless consonants preferentially occurring in the small phrase of each pair. To avoid undefined odds-ratios, we added a count of 0.1 to any category that had recorded a 0, and subtracted 0.1 from the complementary category (e.g., the phrase "really big deal" contains no voiceless consonants, but it was counted as having 0.1 voiceless consonants and 5.9 voiced ones). We also computed 13 similar odds ratios for vowels, using the counts of high-front to other vowels in small versus big members of the pair.

Next, pitch difference scores were calculated for each phrase. The filler stories in each participant's recording provided a baseline log-transformed pitch with which to normalize for individual differences across productions of a given phrase, and then all participants' productions of that phrase were averaged together. The difference score was computed as the difference between the average log-transformed pitch of the small member of the pair and the average log-transformed pitch of the big member of the pair.

Finally, these pitch difference scores were regressed on the logarithms of the consonant odds ratios and the vowel odds ratios, and their interaction. These three predictors failed to account for a significant portion of the variance in pairwise differences, multiple-$R^2 = .09$, $F(3, 9) = 0.30$, *n.s.* Thus, the regression failed to provide evidence that phonological differences between the phrase pairs of size stories related to the observed differences in pitch across the pairs.

Another possible explanation for our results is that participants might have been consciously aware of the speed and size manipulations in the stories. Given the experimental context of reading stories to one another, they might have then deliberately modified their

Table 6
Distribution of consonants and vowels across contrasting material from size stories

	Small	Big	Odds-Ratio
Consonants			
Voiceless	47	38	1.50
Voiced	52	63	
Vowels			
High-front	14	14	1.06
Other	17	18	

Note. The odds ratio compares the odds of the higher-pitched feature occuring in small versus big phrases.

speech in iconic emphasis of these meanings. However, post-experiment questionnaires mitigate this concern to some extent. When participants were asked what they thought the study was about and whether they noticed anything in particular about the stories, the majority made no mention of noticing particular meanings in the stories. The 34% who did suggested that the stories had something to do with emotional contrasts like happy versus sad, and not a single participant noticed the semantic contrasts of speed or size. Thus, the results of the questionnaire suggest that participants employed these iconic modulations spontaneously in the task, without conscious deliberation.

3. General discussion

The purpose of the present study was to advance investigation into the phenomenon of iconic prosody in speech production. Our story reading task focused on meanings related to the concepts of speed and size, considering both concrete and abstract senses of these terms. We found that when participants read aloud stories relating to speed, their readings of fast stories were significantly faster than slow counterpart stories. This difference was significant across both contrasting and shared phrases. The lack of interaction between speed and contrast suggests that the influence of speed was distributed across the story, including portions in which speed was not explicitly mentioned. Participants' readings of size stories also showed an iconic effect in prosody, with small stories read with a higher pitch than large stories. In this case, the difference was localized to phrases making explicit mention of size; shared sections of size stories did not significantly differ in pitch. Notably, we did not find pitch effects in the speed stories or articulation rate effects in the size stories.

As a whole, these results reinforce previous research showing that speakers spontaneously modulate their prosody in iconic relation to the meaning they are expressing. Further, the distinction between the widely dispersed articulation rate differences for speed stories, and the more narrowly concentrated pitch differences for size stories suggests that the modulations are not due simply to automatic, linear activation of word meanings, which would generate only localized effects in the contrasting phrases. Rather, it appears that the different concepts of speed and size may lend themselves to different temporal patterns of iconic prosody. One possible explanation of these different temporal patterns is that they reflect the conceptualization of speed as a dynamic, ongoing property of events that lasts throughout the stories, and size as a more static, localized property of objects and other entities that is relevant only when they are in focus.

An additional goal of the study was to examine whether people produce iconic modulations of prosody when expressing abstract senses of speed (e.g., fast/slow career progress) and size (e.g., small/big deal). We failed to find significant interactions of concreteness with either speed or size. Thus, although the concrete senses elicited numerically larger effects, especially for speed, the results provide tentative evidence that abstract meanings have the potential to elicit conceptually motivated modulations of prosody.

While the small number of items in the present experiment does not permit much generalization, these results on the use of iconic prosody to express abstract senses of concrete terms offer some direction for further inquiry. One possibility is that some abstract concepts may tend to manifest more distinctly in iconic prosody than others. For example, vocal iconicity for concrete object properties like size, where we found evidence that the activated concept is concentrated on the articulation of particular size-related words, and which has a well-established symbolic phonetics, may be more flexibly applied to related abstract concepts. Alternatively, it may be that the vocal iconicity underlying more abstract meanings is generally attenuated in degree or activated with more variability (cf. Bergen, Lindsay, Matlock, & Narayanan, 2007).

3.1. Origins and semantic scope of iconic prosody as gesture

Some scholars have previously proposed that iconic modulations of prosody, such as those examined here, may be considered qualitatively as a form of gesture (Liddell, 2003; McNeill, 2005; Okrent, 2002; Perlman, 2010; Shintel et al., 2006). This account poses that speakers conceptualize and express non-vocal domains like speed and size, in part, by iconic movements of their vocal tract. Indeed, the introductory example of David Arora gesturing and vocalizing to depict the length of a mushroom's "long stem" hints at a close connection between iconic manual gestures and iconic prosody. However, this raises the question of how iconic prosody might come to be incorporated into one's conceptualization of non-vocal domains like speed and size. We hypothesize that such associations are likely to develop between non-vocal concepts and prosodic qualities of the voice to the extent that they are correlated in experience—including experience with cultural conventions—and lend themselves to abstract structural correspondences (cf., primary metaphors; Grady, 1999).

For example, people might develop a mapping between speed and speech rate as these domains are likely to be correlated in experience. As people act fast, they are generally more inclined to talk fast—a correlation that follows from the finding that physiological arousal is associated with a faster speech rate (Banse & Scherer, 1996). In support of this idea, it has been found that radio play-by-play of live action in a soccer match roughly tracks the pace of action in the game. Play-by-play narration exhibits a faster speech rate than that of speech providing background information or color commentary, with speech rate increasing (accomplished by shorter and less frequent pauses) as suspense builds, and normalizing after dramatic events like goals (Kern, 2010). This correlation is also supported by work on listeners' processing of speech rate iconicity, which shows that listeners are sensitive to the articulation rate of the speech, with shorter reaction times in a true-false judgment task after fast speech, but only when the speech described an urgent or hurried scenario (Shintel & Nusbaum, 2008). These results point to how an accelerated or slowed articulation rate might come to embody one's more general concept of fast or slow motion. Thus, similar to the production of manual iconic gestures, when people think and talk about fast or slow speed, their conceptualization might manifest through iconic prosody that reflects this correspondence.

A plausible account also exists for the experiential correlation between pitch and size, which is thoroughly reviewed by Ohala (1984). As the basis for this correlation, the physics of sound entail that larger objects generally make lower-frequency sounds than smaller ones. The pattern also applies to the pitch of animal vocalizations, with larger animals generally producing lower pitched sounds and smaller animals producing higher pitched sounds (a fact lexicalized in the phrase “pip-squeak”). Moreover, this experiential correlation has been argued to be significant in the evolution of ritualized vocal signals in many vertebrates (Morton, 1977). Across species as diverse as dogs, chickadees, rhinoceroses, and frogs, lower-pitched sounds are used for threat displays (when an individual might benefit from others’ reacting as if it is larger than it really is), while higher-pitched sounds are used in nonaggressive contexts (when it can be beneficial to be small and non-threatening). These patterns suggest that the association between pitch and size may be gained through experience, but it may also have a reinforcing basis that is inherited from our evolution.

Thus, through such experiential correlations, people’s concepts of qualities like speed and size might come to be embodied in the articulatory movements of their vocal tract. We propose that, like manual iconic gestures, the vocal embodiment of these conceptualizations becomes active when people talk and think about concepts like speed and size, and that iconic prosody is produced when this activity reaches a certain threshold (cf. Hostetter & Alibali, 2008).

Considered together, our results, along with those of other recent studies, point to several mappings that appear to be embodied in iconic prosody, including speed, verticality, and size. Yet what other semantic domains might elicit the production of iconic prosody? Compared to the visuospatial modality utilized by manual gestures, some scholars have made the argument that the vocal-auditory modality is severely limited in its potential for iconic representation (Armstrong & Wilcox, 2007; Hockett, 1978; Liddell, 2003; Tomasello, 2008; also see Pinker & Jackendoff, 2005 on vocal imitation). As Hockett reasons (1978, p. 274):

> When a representation of some four-dimensional hunk of life has to be compressed into the single dimension of speech, most iconicity is necessarily squeezed out. In one-dimensional projection, an elephant is indistinguishable from a woodshed. Speech perforce is largely arbitrary.

While such reasoning may seem intuitive, it is unclear the extent to which it is biased by the methodological (and casual observational) challenge of identifying iconic prosody and separating it from the “non-iconic” part of the speech signal, including syntactic and phonological factors. Indeed, one might counter that speech too is multidimensional, consisting of variable properties like fundamental frequency, intensity, duration, as well as more complex qualities of timbre like harmonics-to-noise ratio.

In contrast to this view, substantial experimental work in sound symbolism and cross-linguistic research on the rich systems of onomatopoeia in various languages points to many other potential domains for iconic prosody (Dingemanse, 2012; Hinton, Nichols, & Ohala, 1994; Nuckolls, 1999; Perniss et al., 2010). This research, which implicates a role for vocal iconicity in the diachronic development of languages, has found that the conventional gestures of speech are used in the iconic expression of a disparate array of meanings relating to *shape*, *manner of motion*, *physical texture*, *brightness*, *distance*, and *gender*, among numerous other concepts. Further research should aim to observe the ways in which these various concepts might manifest more dynamically in the iconic prosody of speech (as well as in exaggeration of the phonetic features of speech; Feist, 2013; Perlman, 2010).

4. Conclusion

A challenge for researchers is to develop methods and analyses that facilitate the identification and measurement of iconic prosody, especially within more naturalistic contexts and across languages. The goal of the present study was to expand the scope of semantic domains examined in research on iconic prosody and to enable a more fine-grained examination of the phenomenon. Notably, the results show different temporal patterns of iconic prosody between the conceptual domains of speed and size, which presents a significant consideration as researchers seek to understand how iconic prosody might manifest over the time course of an utterance. More generally, the findings contribute to a small but growing set of studies suggesting that iconic prosody in the expression of speed is readily elicited in English speakers in a range of contexts, from the production of controlled sentences describing a moving dot in a computer experiment, to reading stories, to the spontaneous description of video clips. These studies additionally indicate that iconic prosody relating to some other conceptual domains, like size and verticality, might also be elicited with some facility.

Yet beyond these few experiments, very little is known about iconic prosody in the wild. We know almost nothing, for example, regarding the online relationship between manual iconic gesture and iconic prosody during the production of speech, such as their relative frequency of occurrence or whether they might tend to co-occur with each other. Ultimately, if we are to understand the relationships between speech, gesture, and the conceptual processes that are involved in their production, it is crucial that we gain a deeper and more comprehensive understanding of iconic prosody and other vocal iconic phenomena.

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References

Alpher, B. (2001). Ideophones in interaction with intonation and the expression of new information in some indigenous languages of Australia. In F. Erhard, K. Voeltz & C. Kilian-Hatz (Eds.) *Ideophones* (pp. 9–24). Amsterdam: John Benjamins.

Armstrong, D. F., & Wilcox, S. (2007). *The gestural origin of language*. New York: Oxford University Press.

Banse, R., & Scherer, K. R. (1996). Acoustic profiles in vocal emotion expression. *Journal of Personality and Social Psychology*, *70*(3), 614–636.

Bergen, B., Lindsay, S., Matlock, T., & Narayanan, S. (2007). Spatial and linguistic aspects of visual imagery in sentence comprehension. *Cognitive Science*, *31*, 733–764.

Boersma, P. (1993). Accurate analysis of the fundamental frequency and the harmonics-to-noise ratio of a sampled sound. *Institute for Phonetic Science, University of Amsterdam, Proceedings*, *17*, 97–110.

Boersma, P. (2001). Praat, a system for doing phonetics by computer. *Glot International*, *5*, 341–345.

Bolinger, D. (1986). *Intonation and its parts: Melody in spoken English*. Palo Alto, CA: Stanford University Press.

Bryant, G. A., & Fox Tree, J. E. (2002). Recognizing verbal irony in spontaneous speech. *Metaphor and Symbol*, *17*(2), 99–117.

Childs, G. T. (1994). African ideophones. In L. Hinton, J. Nichols & J. J. Ohala (Eds.) *Sound Symbolism* (pp. 178–206). Cambridge: Cambridge University Press.

Cienki, A., & Müller, C. (2008). Metaphor, gesture, and thought. In R. W. Gibbs Jr (Ed.), *The Cambridge handbook of metaphor and thought* (pp. 483–501). Cambridge, UK: Cambridge University Press.

Cosmides, L. (1983). Invariances in the acoustic expression of emotion during speech. *Journal of Experimental Psychology: Human Perception and Performance*, *9*, 864–881.

Diffloth, G. (1972). The notes on expressive meaning. In P. M. Peranteau & J. N. Levi and G. C. Phares (Eds.) *Papers from the Eighth Regional Meeting of Chicago Linguistic Society* (pp. 440–447). Chicago: Chicago Linguistic Society.

Dingemanse, M. (2012). Advances in the cross-linguistic study of ideophones. *Language and Linguistics Compass*, *6*, 654–672.

Duncan, S. D. (2003). Gesture in language: Issues for sign language research. In K. Emmorey (Ed.), *Perspectives on classifier constructions in signed languages* (pp. 259–268). Mahwah, NJ: Lawrence Erlbaum Associates.

Feist, J. (2013). "Sound symbolism" in English. *Journal of Pragmatics*, *45*, 104–118.

Ferreira, F. (1993). Creation of prosody during sentence production. *Psychological Review*, *100*, 233–253.

Grady, J. (1999). A typology of motivation for conceptual metaphor: Correlation vs. resemblance. In G. Steen & R. Gibbs (Eds.), *Metaphor in cognitive linguistics* (pp. 79–100). Philadelphia: John Benjamins.

Hanson, H. M. (2009). Effect of obstruent consonants on fundamental frequency at vowel onset in English. *Journal of the Acoustical Society of America*, *125*(1), 425–441.

Hinton, L., Nichols, J., & Ohala, J. J. (Eds.) (1994). *Sound symbolism*. Cambridge, UK: Cambridge University Press.

Hockett, C. F. (1978). In search of Jove's brow. *American speech*, *53*(4), 243–313.

Hostetter, A., & Alibali, M. W. (2008). Visible embodiment: Gestures as simulated action. *Psychonomic Bulletin & Review*, *15*, 495–514.

Jakobson, R., & Waugh, L. R. (1979). *The sound shape of language*. Bloomington: Indiana University Press.

Johnson, K. (1997). *Auditory and acoustic phonetics*. Oxford, England: Blackwell.

Kendon, A. (2004). *Gesture: Visible action as utterance*. Cambridge, UK: Cambridge University Press.

Kern, F. (2010). Speaking dramatically: The prosody in radio live commentaries of football games. In M. Selting, D. Barth-Weingarten, & E. Reber (Eds.), *Prosody in interaction* (pp. 217–238). Amsterdam: John Benjamins.

Levelt, W. J. M. (1989). *Speaking: From intention to articulation*. Cambridge, MA: MIT Press.

Levelt, W., Roelofs, A., & Meyer, A. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, *22*, 1–75.

Liddell, S. K. (2003). *Grammar, gesture, and meaning in American Sign Language*. Cambridge, UK: Cambridge University Press.

McGregor, W. (2001). Ideophones as the source of verb in Northern Australian languages. In F. Erhard, K. Voeltz & C. Kilian-Hatz (Eds.) *Ideophones* (pp. 9–24). Amsterdam: John Benjamins.

McNeill, D. (1992). *Hand and mind: What gestures reveal about thought*. Chicago: Chicago University Press.

McNeill, D. (2005). *Gesture and thought*. Chicago: Chicago University Press.

Mikone, E (2001). Ideophones in the Balto-Finnic Languages. In F. Erhard, K. Voeltz & C. Kilian-Hatz (Eds.) *Ideophones* (pp. 9–24). Amsterdam: John Benjamins.

Morton, E. W. (1977). On the occurrence and significance of motivation-structural rules in some bird and mammal sounds. *American Naturalist*, *111*, 855–869.

Nuckolls, J. (1999). The case for sound symbolism. *Annual Review of Anthropology*, *28*, 225–252.

Nygaard, L. C., Herold, D. S., & Namy, L. L. (2009). The semantics of prosody: Listeners' use of acoustic correlates to word meaning. *Cognitive Science*, *33*, 127–146.

Ohala, J. J. (1984). An ethological perspective on common cross-language utilization of F0 of voice. *Phonetica*, *41*, 1–16.

Ohde, R. N. (1984). Fundamental frequency as an acoustic correlate of stop consonant voicing. *Journal of the Acoustical Society of America*, *75*(1), 224–230.

Okrent, A. (2002). A modality-free notion of gesture and how it can help us with the morpheme vs. gesture question in sign language linguistics. In R. P. Meier, K. Cormier, & D. Quinto-Pozos (Eds.), *Modality and structure in signed and spoken languages* (pp. 175–198). Cambridge, UK: Cambridge University Press.

Parise, C. V., & Pavani, F. (2011). Evidence of sound symbolism in simple vocalizations. *Experimental Brain Research*, *214*, 373–380.

Perlman, M. (2010). Talking fast: The use of speech rate as iconic gesture. In F. Perrill, V. Tobin, & M. Turner (Eds.), *Meaning, form, and body* (pp. 245–262). Stanford, CA: CSLI Publications.

Perlman, M., Dale, R., & Lupyan, G. (2014). Vocal charades: The emergence of conventions in vocal communication. In E. A. Cartmill, S. Roberts, H. Lyn, & H. Cornish (Eds.), *The evolution of language: Proceedings of the 10th International Conference (EVOLANGX)* (pp. 236–243). Hackensack, NJ: World Scientific.

Perniss, P., Thompson, R. L., & Vigliocco, G. (2010). Iconicity as a general property of language: Evidence from spoken and signed languages. *Frontiers in Psychology*, *1*, 1–14.

Pinker, S., & Jackendoff, R. (2005). The faculty of language: What's special about it? *Cognition*, *95*, 201–236.

Sapir, E. (1929). A study in phonetic symbolism. *Journal of Experimental Psychology*, *12*, 225–239.

Schultze-Berndt, E. (2001). Ideophone-like characteristics of uninflected predicates in Jaminjung (Australia). InF. Erhard, K. Voeltz & C. Kilian-Hatz (Eds.) *Ideophones* (pp. 9–24). Amsterdam: John Benjamins.

Shintel, H., & Nusbaum, H. C. (2008). Moving to the speed of sound: Context modulation of the effect of acoustic properties of speech. *Cognitive Science*, *105*(6), 1063–1078.

Shintel, H., Nusbaum, H. C., & Okrent, A. (2006). Analog acoustic expression in speech communication. *Journal of Memory and Language*, *55*, 167–177.

Tomasello, M. (2008). *Origins of human communication*. Cambridge, MA: MIT Press.

Tsur, R. (2006). Size-sound symbolism revisited. *Journal of Pragmatics*, *38*, 905–924.

Ultan, R. (1978). Size-sound symbolism. In J. H. Greenberg, C. A. Ferguson, & E. A. Moravcsik (Eds.), *Universal of human language, vol. 2: Phonology* (pp. 527–568). Stanford, CA: University Press.

Watson, R. L. (2001). A comparison of some Southeast Asian ideophones with some African ideophones. In F Erhard, C. Kilian-Hatz, K. Voeltz & C. Kilian-Hatz (Eds.) *Ideophones* (pp. 9–24). Amsterdam: John Benjamins.

Whalen, D. W., & Levitt, A. G. (1995). The universality of intrinsic F0 of vowels. *Journal of Phonetics*, *23*, 349–366.

Appendix

Table A1
Speed stimuli with syllable counts

Section	Syl.	Fast Text	Slow Text
Character		Martha	Martha
Title		A Rapid Run	A Sluggish Walk
Intro	21	Martha is a fast runner She always exercises, and today she is out there	Martha is a slow walker She rarely exercises, but today she is out there
Contrasting phrase	4	A fast runner	A slow runner
Plot	37	She takes off quickly through the neighborhood. She dashes past some houses and continues toward a school. She speeds to a near-sprint and reaches the final stretch	She labors slowly through the neighborhood. She struggles past some houses and continues toward a school. She slows to a near stop but reaches the final stretch
Contrasting phrase	4	Takes off quickly	Labors slowly
Contrasting phrase	5	Dashes past some houses	Struggles past some houses
Contrasting phrase	5	Speeds to a near-sprint	Slows to a near stop
Conclusion	6	She is reaching the end	She is reaching the end
Character		Bob	Bob
Title		Racing through Traffic	Inching through Traffic
Intro	18	Bob is a middle-aged professional man. He is driving to work, but seems to be flying	Bob is a middle-aged professional man. He is driving to work, but seems to be creeping
Contrasting phrase	6	But seems to be flying	But seems to be creeping
Plot	39	The traffic is light, and Bob quickly races down the highway, darting in and out between the other cars. He keeps racing until he sees the office building	The traffic is thick, and Bob slowly inches down the highway, crawling in and out between the other cars. He keeps inching until he sees the office building
Contrasting phrase	5	Bob quickly races down	Bob slowly inches down
Contrasting phrase	5	Darting in and out	Crawling in and out
Conclusion	5	He is getting there	He is getting there
Character		Diana	Diana
Title		Speeding Down a Road to Nowhere	Limping Down a Path to Nowhere
Intro	25	Diana is a woman in her forties. Her life has suddenly taken some unfortunate turns	Diana is a woman in her forties. Her life has gradually taken some unfortunate turns
Contrasting phrase	6	Has suddenly taken	Has gradually taken

Table A1. (continued)

Section	Syl.	Fast Text	Slow Text
Plot	51	She is speeding down a road to nowhere The economy is bad. Her company has gone out of business. Her skills are no longer needed on the job market. She blazes on toward an uncertain future	She is limping down a path to nowhere The economy is bad. Her company has gone out of business. Her skills are no longer needed on the job market. She hobbles on toward an uncertain future
Contrasting phrase	7	She is speeding down a road	She is limping down a path
Contrasting phrase	4	She blazes on	She hobbles on
Conclusion	6	Her life is changing	Her life is changing
Character		Peter	Peter
Title		The Fast Track to Success	The Slow Path to Success
Intro	22	Peter is a 35-year-old business man. He is taking a fast track to success	Peter is a 35-year-old business man. He is taking a slow path to success
Contrasting phrase	3	A fast track	A slow path
Plot	41	His career is quickly moving forward He is about to be promoted. He has a nice life and a pleasant home. He is heading swiftly in the right direction	His career is slowly moving forward He is about to be promoted. He has a nice life and a pleasant home. He is heading slowly in the right direction
Contrasting phrase	6	Quickly moving forward	Slowly moving forward
Contrasting phrase	4	Heading swiftly	Heading slowly
Conclusion	6	He is reaching his goals	He is reaching his goals

Note. “Bob” and “Martha” items were considered concrete, while “Diana” and “Peter” items were considered abstract.

Table A2
Size stimuli with phonological bias measures for contrasting contrasting phrases

Section	Syl	Big Text	Small Text	C-Bias	V-Bias
Character		Phyllis	Phyllis		
Title		A Giant Elephant	A Tiny Grasshopper		
Intro	19	Phyllis is a humungous elephant. She is on the plain searching for food	Phyllis is a miniscule grasshopper. She is on the plain searching for food		
Contrasting phrase	7	A humongous elephant	A miniscule grasshopper	1.00	1.25
Plot	17	Phyllis lumbers through the grass, casting a massive shadow as she goes	Phyllis hiphops through the grass, casting a tiny shadow as she goes		
Contrasting phrase	5	Lumbers through the grass	Hiphops through the grass	149.50	5.33

Table A2. (continued)

Section	Syl	Big Text	Small Text	C-Bias	V-Bias
Contrasting phrase	5	A massive shadow	A tiny shadow	199.00	1.50
Conclusion	6	She keeps looking for food	She keeps looking for food		
Character		Bonnie	Bonnie		
Title		A Gargantuan Home	An Itty-Bitty Home		
Intro	14	Bonnie is at home. She lives in a very giant house	Bonnie is at home. She lives in a very tiny house		
Contrasting phrase	5	Very giant house	Very teeny house	4.00	1.00
Plot	28	The huge house is in a neighborhood with other gargantuan houses. Each house is on a great big plot of land	The tiny house is in a neighborhood with other itty-bitty houses. Each house is on a little plot of land		
Contrasting phrase	2	Huge house	Tiny house	199.00	1.00
Contrasting phrase	6	Gargantuan houses	Itty-bitty houses	398.00	3.50
Contrasting phrase	6	A great big plot of land	A little plot of land	0.50	1.29
Conclusion	5	This house is her home	This house is her home		
Character		Joe	Joe		
Title		A Really Big Deal	A Pretty Small Deal		
Intro	20	Joe is thinking about signing a record contract. It is a really big deal	Joe is thinking about signing a record contract. It is a pretty small deal		
Contrasting phrase	4	Really big deal	Pretty small deal	1.00	359.40
Plot	23/22	It will have a huge impact on his career. Joe is making a monumental decision	It will have little impact on his career. Joe is making a trivial decision		
Contrasting phrase	5	Have a huge impact	Have little impact	4.00	0.60
Contrasting phrase	8/7	A monumental decision	A trivial decision	1.00	1.33
Conc.	5	He signs the contract	He signs the contract		
Character		George	George		
Title		A Hefty Price to Pay	A Small Price to Pay		
Intro	25	George is a general. He has just sent a battalion into heavy battle to take over a bridge	George is a general. He has just sent a battalion into a light skirmish to take over a bridge		
Contrasting phrase	4	Heavy battle	Light skirmish	1.00	2.00
Plot	23/22	The casualties will be vast. It is a hefty price to pay, but the enemy must be stopped	The casualties will be slight. It is a small price to pay, and the enemy must be stopped		

Table A2. (continued)

Section	Syl	Big Text	Small Text	C-Bias	V-Bias
Contrasting phrase	3	Will be vast	Will be slight	1.00	1.00
Contrasting phrase	7/6	A hefty price to pay	A small price to pay	0.01	0.24
Conclusion	5	They move toward the bridge	They move toward the bridge		

Note. "Phyllis" and "Bonnie" items were considered concrete, while "Joe" and "George" items were considered abstract. Consonant bias score (C-bias) is the ratio of the odds of voiceless consonants in the small phrase to their odds in the big phrase. Vowel bias score (V-Bias) is the ratio of the odds of high-front vowels in the small phrase to their odds in the big phrase.