Antonym adjective pairs and prosodic iconicity: Evidence from letter replications in an English blogger corpus

Abstract: While the general assumption has long been that natural languages exhibit an arbitrary pairing of form and meaning, there is increasing empirical evidence that iconicity in language is not uncommon. One example from spoken language involves iconic prosodic modulation, i.e. the changing of prosodic features such as duration and fundamental frequency to express meanings such as size and speed. In this paper, we use data from an English social media corpus, with 140 million words written by 19320 bloggers, to investigate a counterpart to iconic prosodic modulation in written language, namely letter replications (e.g. loooong). We examine pairs of gradable adjectives such as *short/long*, *tiny/huge* and *fast/slow*, finding a higher frequency of letter replications for adjectives associated with greater size or spatial/temporal extent. We did not find an iconic effect on the number of letter replications. Our results show evidence for iconic prosody in written language, and further demonstrate that social media databases offer an excellent opportunity to investigate naturalistic written language.

Words: 162

Keywords: Iconic lengthening, prosody, social media, English, scalarity

1 Introduction

1.1 Iconicity

It is frequently assumed that one "design feature" of language is that there is no relation between sound and meaning (Hockett 1960), which makes languages so different and flexible. However, there is accumulating empirical evidence that this statement is only partially true and some degree of iconicity, i.e. an association between form and sign, may have been necessary specifically in certain periods of mankind and human interaction. Perniss and Vigliocco (2014) argue that "iconicity is a fundamental property of language, representing an adaptation to a critical constraint on the phylogenesis, ontogenesis and use of language, namely the need to map linguistic form to human (sensory, motor and affective) experience." (p.2).

One well known example of iconicity involves systematic shape-sound correspondences such as the so-called 'bouba/kiki' effect, where rounded and non-rounded mouth shapes and tongue movements in production are systematically associated with rounded and pointy shapes, respectively (Köhler 1929; Ramachandran and Hubbard 2001; Maurer et al. 2006). As evidence of the widespread nature of iconicity, Blasi et al. (2016) analyzed 100 basic vocabulary items in 4298 different languages and 359 lineages, finding a large proportion to exhibit non-arbitrary sound-meaning relations which cannot be explained due to language contact. For example, words for tongue tend to contain /l/, while those for nose tend to contain /n/. Thus, iconicity in spoken language may be less exceptional than expected. It has even been studied in the context of consumer judgements in brand names (Yorkston and Menon 2004). Brand names for ice cream differing only in the two phonemes /i/ and /ɛ:/ or /ʌ/[1] revealed different consumer judgements on richness, smoothness, and creaminess. Brand names with /ɛ:/ were associated with heavier, richer, and creamier ice cream. This association is based on sound symbolism and that more front vowels

[1] The authors describe [ä] as a phoneme, but this is not a phoneme in the IPA, hence we replaced it by a phoneme which we thought might correspond. However, at a later place the authors provide an example for a corresponding word <but> and according to this one, the [ä] might be [ʌ].

would be associated with “smallness, lightness, mildness, thinness, fastness, coldness, bitterness, femininity, weakness, lightness, and prettiness” (Yorkston and Menon, 2004, p.44) in comparison to more back vowels. The authors suggest that the preference for one or another based on sound symbolism is below the customer’s awareness.

1.2 Adjectives and scalar meaning as a semantic domain for iconicity

A semantic domain where iconicity is well documented involves scalar dimensions such as size, duration and speed. Such meanings are expressed by words of a variety of grammatical categories, including nouns, verbs and prepositions, but most typically represent the semantic content of gradable adjectives such as *large/small, long/short* and *high/low*. Gradable adjectives as a class can be identified by their occurrence in the comparative form (e.g. *larger*, *longer*). Formally, they may be analyzed as lexicalizing mappings from individuals to degrees on scales (Bierwisch 1987). Typically, such adjectives occur in antonym pairs, where one adjective is associated with the “large” direction on the scale while its antonym is associated with the “small” direction. Often, the adjective that corresponds to the “large” direction is the unmarked one. This manifests itself in several ways, one being the interpretation of questions: “How long is X?” does not presuppose that X is long, whereas “How short is X?” presupposes that X is short. However, this is not always the case. There are adjectives denoting very high degrees, like *huge*, that are marked, and there are antonym pairs where neither member is unmarked (e.g. *poor* and *rich*). Below we will see a further instance of divergence between largeness and unmarkedness that will prove relevant for the understanding of iconic effects in this domain.

A variety of factors make scalar meaning a natural place to expect iconicity in language, including humans’ ability to associate magnitudes across modalities (Cuskley and Kirby 2013) as well as regular co-occurrences in the external world, such as that between the size of animals and the fundamental frequency and resonance of their vocalizations (Ohala 1984; 1994; 1997). Larger animals produce lower vocalizations, because their vocal folds might be longer and heavier resulting in a lower voice

in comparison to smaller ones (Ohala 1994 citing Morton 1977). Hence based on the acoustic properties of the vocalizations, animals can roughly estimate the size of a potential aggressor and behave in the appropriate manner.

Recently, Knoeferle et al. (2017) tested the role of the acoustic properties in humans. They visually presented participants objects of different size with audible nonsense speech material that differed with respect to vowel duration, formants, intensity and fundamental frequency. Participants had to judge which object would fit with the audible sound. Their results revealed an iconic effect of object size on vowel duration and the first formant (F1), but not in the other parameters. Larger objects were associated with longer duration and higher F1.

1.3 Produced and perceived iconicity in the prosody of adjectives

Prosody can also contribute to iconicity in spoken language, for example by an extra lengthening of the vowel in *long* in referring to the experience of an event taking a long time. Schlenker (in press) has recently proposed that such lengthening is an iconic enrichment of arbitrary encoding of linguistic meaning. Iconic prosodic modulation consists of changing certain prosodic features such as duration, fundamental frequency (F0), or amplitude to express additional meaning. In this line, Nygaard et al. (2009) investigated the relation between prosody and meaning in two experiments. Three speakers had to read novel words in an infant-directed speech style to stimulate a situation of engagement. The novel words, embedded in a frame sentence, were first read with a relatively neutral prosody as a baseline. Hereafter, the words were presented together with pictures that referred to the meaning of an adjective from the pairs: *happy/sad, hot/cold, big/small, tall/short, yummy/yucky*, and *strong/weak*. Speakers had to read the words again. Differences in acoustic properties were found (mean F0, F0 variation, duration, and amplitude) depending on the adjective. The authors also investigated whether listeners could reliably infer the meaning of these novel words. For this purpose, listeners saw two pictures representing an antonym pair, heard one of the previously recorded sentences, and had to choose the picture that would correspond to the

perceived novel word. Listeners were significantly better in choosing the right picture when listening to the speaker's meaningful prosody than to the speaker's neutral prosody as well as when prosody matched than when it mismatched. The authors suggest that prosody could augment, disambiguate, or reinforce meaning (p.142).

Perlman (2010) showed video clips involving fast and slow events to the participants of the experiment. They had to retell the different events and they did so by generally talking faster for the faster events and slower for the slower ones without being instructed to do so. In a more recent study, Perlman et al. (2015) extended these findings from the manner of motion to the size of an entity and additionally from concrete to abstract meanings (e.g. concrete: a *fast* drive; abstract: *slow* career progress). Speakers had to read short stories involving one of these semantic dimensions to a partner. The authors predicted that stories with different manners of motion would go hand in hand with prosodic variation in duration, but not fundamental frequency, while the reverse should be the case for stories varying adjectives corresponding to the dimension of size. Their findings show that stories in the small condition were read with higher F0 than stories in the large condition, for both abstract and concrete meanings. Moreover, stories in the fast condition were read within a shorter duration than stories in the slow condition and no differences in F0 were found. Thus, different acoustic parameters may be used to mark different semantic dimensions.

In three experiments, Shintel and colleagues (Shintel et al. 2006) recorded speakers who described either a dot moving in upward and downward direction or dots moving with different speed. They could show that motions in the vertical dimension go hand in hand with changes in F0 in a similar direction and changes in speed coincided with changes in speech rate. In some follow up studies, Shintel and Nusbaum (2008) could also provide evidence that the speed of recorded instructions influenced the time of listener's response. In Shintel et al. 2014 the findings were extended to novel word learning, showing that congruent prosody has a positive effect on memory consolidation.

The iconic representation of scalar meaning is also not limited to the spoken modality. In signed languages including American Sign Language (ASL) and Italian Sign Language (LIS), adjectival and verbal scales are in some cases visually represented in the signing space, a pattern that has been characterized as iconic (Wilbur 2012, Aristodeomo and Geraci 2017, Kuhn ms.). In LIS, for example, comparative *taller* can be signed via hand movement in the upward direction. Furthermore, the production of signs may be modulated with semantic effect, as when the slower-than-normal signing of a verb conveys that the corresponding event was a slow one (Wilbur 2008). Similar effects are discussed in Schlenker et al. (2013). In ASL, the sign GROW can be realized with different speed and different maximal distance of the hands. In the ASL translation of the sentence *My group has been growing* the named parameters – speed and amplitude – are decisive for the interpretation of the sentence. Depending on these parameters and the iconic mapping, it can express that the group grew quickly or slowly and a lot or only a bit.

Here, the question naturally arises what exactly has to be counted as an ASL *sign* and what is actually gesture (see Goldin-Meadow and Brentari 2017 for an overview and for discussion). Are all these individual manipulations gestural modifications of the actual sign or is this mode of realization more on the grammatical side, belonging to the sign as such? In spoken language, speech-accompanying gestures can take over this part of modifying what is said in iconic ways (see McNeill 1992 and Kendon 1980 for discussion of speech-accompanying gestures and their iconic character). For example, when talking about a painting, the utterance can be accompanied by an 'oval'-gesture or a 'rectangular'-gesture thus indicating whether the painting is actually oval or rectangular.

Schlenker (2017) distinguishes between external and internal (i.e. syntactically (in)eliminable) enrichments. Speech accompanying gestures in spoken language would be of the former kind, while the prosodic modulations we discussed in the beginning would be of the latter kind, as would the discussed modulations of speed and amplitude in sign languages.

1.4 New prospects on prosody with recent technological developments

With the progress in technology (e.g. computer, smartphones, tablets, fiber optic cables, satellites), digital communication has had an enormous impact on our daily life, our communication tools and styles. Social media platforms have been developing (e.g. twitter, instagram, facebook, chats, whatsapp, blogs) in parallel.

Social media data have some common features with spoken language, since writers do not follow all the formal rules of traditional written norms, and they are further enriched with icons of emotional expressions (emojis). These platforms provide a great opportunity to investigate the dynamics and creativity in the use of written language beyond prescriptive rules (Kaye et al. 2017, Huang et al., 2016). Using social network databases has the advantage of getting a vast amount of data in completely natural settings, with participants that would not feel constraint like in laboratory experiments. It has, however, the disadvantage that the data might be confounded by many unknown factors. So far most studies have tested for iconicity in prosody using rather contrastive settings. Perlman and colleagues (Perlman et al., 2008) write that "[r]emarkably little is known about how speakers use iconic prosody in the wild" (p.1349). Our work contributes in this respect by using a social media corpus.

Among others, the idea of using social media for a better understanding of prosody goes back to Brody and Diakopoulos (2011), who considered word lengthening by letter replications as a substitute for prosodic emphasis. These letter replications are a way of signaling the writer's sentiment and emotion in written text where some properties of spoken language, like intonation, are partially absent. Letter replications also represent a possible candidate for a feature of written language that may have an iconic effect, in that the lengthened pronunciation of a word such as *long* in spoken speech can be reflected in writing via replications, as in *looonng*. To date, however, this has not been systematically researched for antonym pairs.

1.5 Research questions and expectations

In this paper, we investigate the presence of iconic prosody in written language. Based on the literature on prosody and iconicity, we focus on scalar meaning as expressed by gradable adjectives, and on letter replications as a prosodic feature with a potentially iconic effect. The following specific research questions were asked:

1. In which adjectives does lengthening (letter replications) occur?

Since we assume that prosody and letter replications have some degree of iconicity, we predict that letter replications are a phenomenon in adjectives that express the larger size, e.g. in *long* rather than in *short*.

2. If replications occur, of how many letters do they consist?

We expect longer words for the larger size dimension.

2 Methodology

2.1 The blogger corpus

An English social media corpus was used. The corpus is freely available for non-commercial use. It consists of approximately 140 million words written by 19320 bloggers in August 2004 (Schler et al. 2006). The age of the bloggers ranges from 13-47 (in three age groups) with an equal number of males and females. Additional information about profession are provided, but these were not taken into account.

2.2 Selected adjectival antonym pairs

Drawing on the studies of iconic prosody in spoken language discussed in the introduction, the following antonymic pairs of gradable adjectives were selected for investigation (Table 1).

Table 1: *Adjectival antonym pairs*

Antonym pairs	
Smaller degree	*Larger degree*
short	long
small	big
tiny	huge
near	far
fast	slow
thin	fat
narrow	wide
low	high

In each case, one member of the pair expresses a greater degree of size, extent or duration, while the other expresses a lesser degree. Here we note that the ordering of the pairs in Table 1 is based on "largeness", not markedness. As discussed in the introduction, these properties typically coincide. However, the pair *slow* and *fast* represents an exception: *fast* is arguably the unmarked term (cf. "How fast did he walk?" vs. "How slow did he walk?"), but it is instead *slow* that is associated with larger temporal extents, because a slow event requires more time than a fast one. We thus expect *slow* to be targeted for lengthening more often than *fast*.

Note also that the adjective pairs *short-long*, *near-far*, *fast-slow*, *narrow-wide*, *thin-fat* correspond to the horizontal axis while the *low-high* pair corresponds to the vertical axis and *small-big*, *tiny-huge* do not make specific reference to the axis and are rather general size properties.

2.3 Data extraction and preprocessing

The NLTK toolkit was used as a natural language processing environment to tokenize the corpus (http://www.nltk.org/api/nltk.tokenize.html). All lower- and upper-case tokens were considered together. To further process the data, we used Python 2.7. and R Core Team (2017).

In a first step all replications of letters were removed from the selected adjectives in Table 1. This also included replications which are the orthographic norm (e.g. double *l* in small) and resulted in an order of strings. Hereafter, we searched for these string orders including repetitions of the same strings. From the resulting corpus the following words were eliminated: all words that do not involve

all the letters of the original word (e.g. *narow* instead of *narrow*), all words that differed in just one letter and could potentially be typos (e.g. *thinn* instead of *thin*), and finally all words that might have a different meaning (e.g. *tinny* instead of *tiny*).

Furthermore, we calculated the overall number of cases for each adjective with and without letter replication. The number of cases without letter replications served as a baseline to calculate how often bloggers wrote the specific word in the orthographic norm. The number of cases including additionally letter replications was set to 100 percent for each adjective to calculate the frequency at which bloggers wrote the selected adjectives with letter replications.

In addition, we calculated the length of the words as the number of all letters as well as the number of replicated letters.

3 Results

3.1 Percentage of adjectives with letter replications

Table 2: *Adjectival antonym of dimensional pairs*

Antonym pairs				**Fisher's exact test**	
Smaller degree	*Larger degree*	*Percentage (small)*	*Percentage (large)*		
short (n=10848)	*long* (n=44819)	0.018%	1.348%	**p<**	**0.00001**
small (n=12487)	*big* (n=29007)	0.024%	0.155%	**p<**	**0.0001**
tiny (n=2317)	*huge* (n=8556)	0.13%	0.725%	**p<**	**0.0003**
near (n=6557)	*far* (n=19424)	0.015%	0.0721%	p=	0.1364
fast (n=7827)	*slow* (n=4696)	0.102%	0.958%	**p<**	**0.00001**
thin (n=1427)	*fat* (n=5886)	0.070%	0.068%	p=	1
narrow (n=458)	*wide* (n=1915)	0%	0.209%	p=	1
low (n=5022)	*high* (n=16159)	0.060%	0.037%	p=	0.4508

Almost all antonym pairs show a higher frequency of letter replications in the adjectives corresponding to the "larger" scalar direction. Letter replications are significantly more often used in the adjectives *long*, *slow, big* and *huge* than in their respective antonyms. For example, out of all occurrences of *long* in the corpus (n=44819) in 1.35 % of the cases, the word was spelled with letter replications, i.e. different from the orthographic norm. These replications were very unlikely typos, since we excluded all data with just one additional letter from the norm (all words with letter replications are included in the appendix).

The percentage of occurrences of letter replications can be seen in highly frequent words in the corpus (e.g. *long* with n=44819), but also in less frequent words (e.g. in *slow* with n= 4696). The group of adjectives with larger degrees is however, realized much more frequently than the group of adjectives with smaller degrees (see Table 2).

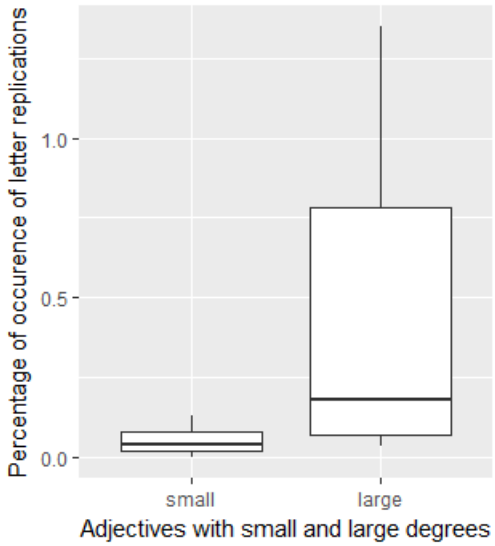

Figure 1: Boxplots with percentage of occurrence of letter replications in the selected adjectives with respect to their overall occurrence without replications (y-axis), split by adjective group (adjectives with smaller degrees on the left and with larger degrees on the right)

Figure 1 summarizes these findings by comparing the two adjective groups in general. Adjectives with larger degrees are not only significantly more often found, they are also more variable (see Figure 1).

3.2 Number of repeated letters in words with letter replications

In a next step we investigated whether the number of repeated letters (in words with letter replications) would also differ among the adjectival antonym pairs. Figure 2 shows boxplots summarizing the length of words (as number of letters) only in those antonym pairs that were significantly different in frequency. Note that boxplots corresponding to adjectives with smaller degrees include fewer data points than adjectives with larger degrees.

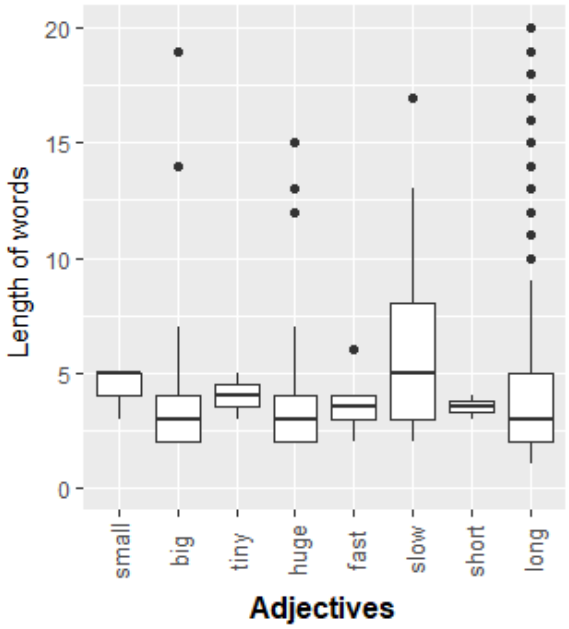

Figure 2: Boxplots with replication length (number of letters for words with replications only. The number of letters for the default word was subtracted from the overall number of letters to account for differences in word length among adjective pairs). Adjective pairs are written on the x-axis.

Overall, no consistent differences were found. In the *small-big* and *tiny-huge* pairs, the adjective with the smaller degrees showed 1-2 more letters than the adjective of the larger degree. In the *fast-slow* and *short-long* pairs the number of letters may be comparable, but overall the adjectives *slow* and *long* are written with a large variability. On the basis of these findings we can exclude the possibility that writers on average lengthen all words with larger degrees in comparison to words with smaller degrees. Antonym pairs were however, not obtained in a contrastive context like: *fasssttt* versus *slooooooooooow*. It might well be possible that differences occur when used as antonym pairs.

4 Discussion and conclusion

With this work, we contribute to the growing literature that shows that natural language is to some extent iconic. Considering the four pairs that show a significant difference of the involved items in the percentage of occurrences with letter replications (*short-long, big-small, tiny-huge, fast-slow*), it is always the adjective corresponding to the "large" direction of the scale that occurs more often in a lengthened version (*long, big, huge, slow*). We did not, however, find an iconic effect on the word length for words with letter replications.

We would like to stress that it is arguably the adjective expressing larger degree that is lengthened and the relevant distinction is not between positive vs. negative or unmarked vs. marked adjectives. The pair *fast-slow* is particularly insightful here. While semantically *fast* is the unmarked adjective of the two (i.e. not presupposing anything when used in the comparative), it is *slow* that occurs more often with letter replications, corresponding to the iconic effect that we expect. These results cannot be explained with respect to sound symbolism in the antonym pairs we selected: the short-long pair differs only marginally in vowel quality (/ɔ/ versus /o/), the big-small pair behaves in the opposite direction as one would predict according to sound symbolism (/i/ being smaller than /a/, see Shinohara and Kawahara 2010), the tiny-huge pair is difficult to compare, since the first adjective

involves the diphthong /aɪ/ with two vowels differing in vowel height and backness. In the fast-slow pair the latter adjective involves a diphthong as well /əʊ/.

Although we do not want to exclude the possibility that lengthening via letter replication might have other effects than the iconic mapping effect we argue for, such as e.g. emphasis in general, we are convinced that our data show that iconicity is one guiding factor. The statistic effects we find are even more remarkable since our investigations are based on a naturally occurring non-elicited data set with no artificial contrasts or other contexts that could make the effects even stronger.

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