

Which words are most iconic?

Iconicity in English sensory words

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Some spoken words are iconic, exhibiting a resemblance between form and meaning. We used native speaker ratings to assess the iconicity of 3001 English words, analyzing their iconicity in relation to part-of-speech differences and differences between the sensory domain they relate to (sight, sound, touch, taste and smell). First, we replicated previous findings showing that onomatopoeia and interjections were highest in iconicity, followed by verbs and adjectives, and then nouns and grammatical words. We further show that words with meanings related to the senses are more iconic than words with abstract meanings. Moreover, iconicity is not distributed equally across sensory modalities: Auditory and tactile words tend to be more iconic than words denoting concepts related to taste, smell and sight. Last, we examined the relationship between iconicity (resemblance between form and meaning) and systematicity (statistical regularity between form and meaning). We find that iconicity in English words is more strongly related to sensory meanings than systematicity. Altogether, our results shed light on the extent and distribution of iconicity in modern English.

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1. Introduction

Some spoken words are iconic, exhibiting a resemblance between form and meaning. For instance, the word *boom* bears resemblance to the loud, explosive sound to which it refers, and the word *teeny* conveys a sense of smallness through the high-front vowel /i/ (e.g., Sapir, 1929; Ohala, 1994). Experimental studies show that people can take advantage of iconicity to improvise novel, meaningful vocalizations (Fay, Arbib, & Garrod, 2013; Perlman, Dale, & Lupyan, 2015), and this process can play an important role in the formation of new words (Dingemanse,

2014). Thus, iconicity has been argued to have special significance in the origins of languages, serving to bootstrap the formation of spoken symbols (Imai & Kita, 2014). But how widespread is iconicity across the vocabulary of modern spoken languages? And, which semantic domains are most likely to be expressed with iconic words?

The amount of iconicity in spoken languages has often been dismissed as trivial (e.g., Hockett, 1982 [1960]; Pinker & Bloom, 1990). Linguists traditionally have emphasized the arbitrary nature of language (e.g., de Saussure, 1959 [1916]). This view states that the vocabularies of spoken languages primarily consist of arbitrary word forms that are made meaningful only by convention. But increasingly, the vocabulary of spoken languages is viewed as striking a balance of arbitrariness and iconicity (Waugh, 1994; Perry, Perlman, & Lupyan, 2015; Dingemanse, Blasi, Lupyan, Christiansen, & Monaghan, 2015). Lockwood and Dingemanse (2015) observe that arbitrariness and iconicity “are clearly happy enough to co-exist within language” (p. 11). This marks a shift to looking at the particular contributions of arbitrariness and iconicity as complementary qualities of languages.

Compared to signed languages, spoken languages are generally believed to exhibit less iconicity in their vocabulary because audible vocalizations are thought to afford less iconicity than do visible gestures (Armstrong & Wilcox, 2007; Meir, Padden, Aronoff & Sandler, 2013; Fay et al., 2013). While this *may* be true in gross, the theory that languages exist in a balance of iconicity and arbitrariness demands that we examine how such a balance is achieved and maintained in spoken and signed languages alike. One important factor relates to the particular ways that each modality enables certain concepts to be expressed more easily via iconic signals than others (Dingemanse et al., 2015; Fay et al., 2013; Meir, Padden, Aronoff & Sandler, 2013; Perlman & Cain, 2014). In this paper, we show that English words with meanings higher in sensory information are more likely to have iconic forms. We further show that the relative degree of iconicity differs between sight, sound, touch, taste, and smell.

1.1 Iconicity and the senses

Across spoken languages, one part of vocabulary where iconicity is especially prevalent and well documented is in the lexical class of ideophones (Dingemanse, 2012; Voeltz & Kilian-Hatz, 2001). These words are characterized by their distinctive syntactic and phonological properties and perhaps most notably, by their evocation of vivid sensory-motor imagery. For example, the language Siwu, spoken in Ghana, contains a large number of ideophones, including words like *fwɛfwɛ* ‘springy, elastic’ and *saaa* ‘cool sensation’ (Dingemanse et al., 2015). Virtually all languages may exhibit ideophone-like words in the class of onomatopoeic words

motivated by the imitation of environmental sounds, e.g., *quack* and *bang*. English is no exception, with over 100 onomatopoeic forms documented by Rhodes (1994). Many of the world's languages also have more extensive collections of ideophones, such as many languages in Africa, Asia, and the Americas. For example, Japanese has more than a thousand ideophones for sensory concepts, such as *sara-sara* for smooth surfaces and *zara-zara* for rough surfaces (Watanabe, Utsunomiya, Tsukurimichi, & Sakamoto, 2012:2518).

Surveys of ideophones across languages reveal that they are used to convey a wide range of different meanings, including animate and inanimate sounds, luminance, manner of movement, size, texture, shape, taste, temperature, and emotional and psychological states (Dingemanse, 2012). Based on a review of these ideophone systems, Dingemanse (2012:663) proposes the following hierarchy of meanings:

- (1) SOUND < MOVEMENT < VISUAL PATTERNS < OTHER SENSORY PERCEPTIONS < INNER FEELINGS AND COGNITIVE STATES

The hierarchy reflects how likely certain meanings are encoded in ideophone systems. Accordingly, sound-to-sound mappings (onomatopoeia) should be the most common, followed by sound-to-movement mappings, followed by mappings to other, non-motion visual patterns and so on. Notably, "other sensory perceptions", including touch, taste and smell impressions, are ranked fairly low in this hierarchy. The hierarchy may also have reflections in Indo-European languages, which are notably lacking in ideophones (Vigliocco, Perniss & Vinson, 2014).

Perry et al. (2015) found that in both English and Spanish, onomatopoeic words and interjections are more iconic than other lexical classes. Adjectives, which frequently denote sensory properties, were found to be more iconic than nouns and closed-class words. Moreover, in English – a language in which verbs typically express manner of motion (Talmy, 1991) – verbs were also found to be more iconic than nouns and closed-class words. However, this was not the case in Spanish, where verbs typically do not express manner information.

Laboratory experiments on iconicity also indicate a close connection between iconicity in speech sounds and sensory-related semantics. Experimental studies have tested people's sensitivity to iconicity across a host of semantic dimensions (see Lockwood & Dingemanse, 2015). One well-studied example is the association between nonce words like *bouba* and *kiki* and round and sharp shapes respectively (Fischer, 1922; Usnadze, 1924; Köhler, 1929; Davis, 1961; Ramachandran & Hubbard, 2001; Ahlner & Zlatev, 2010; Nielsen & Rendall, 2011, 2012, 2013, among many others). Another example is the correspondence between particular speech sounds and speed of motion (Cuskley, 2013). Researchers have also found iconicity with respect to non-visual concepts, including taste (Simner, Cuskley,

& Kirby, 2010; Gallace, Boschini, & Spence, 2011; Ngo, Misra, & Spence, 2011; Crisinel, Jones, & Spence, 2012) and textural qualities such as the roughness of surfaces (Fryer, Freeman, & Pring, 2014; Etzi, Spence, Zampini, & Gallace, 2016). What is striking across these experimental studies is that most of the meanings for which reliable iconic associations have been found directly relate to perceptual information, such as shape, size, motion, taste and texture. There also is emerging evidence from neuroimaging studies showing that sensory brain areas are more strongly engaged in the processing of iconic words compared to more arbitrary words (Osaka, Osaka, Morishita, Kondo, & Fukuyama, 2004; Hashimoto, Usui, Taira, Nose, Haji, & Kojima, 2006; Arata, Imai, Okuda, Okuda, & Matsuda, 2010; see discussion in Lockwood & Dingemanse, 2015).

Research on so-called phonesthemes also supports a special role for sensory meanings in iconicity. Phonesthemes are phonemes or phoneme clusters that frequently correspond to particular meanings (see Bergen, 2004; Cuskley & Kirby, 2013), for example, the English cluster *gl-* frequently occurs in words referring to shiny visual phenomena, as in *glitter*, *glimmer*, *glisten* and *glitz*. Among the semantic targets listed in two extensive studies of phonesthemes (Kwon & Round, 2015; Hutchins, 1998), one finds a range of sensory meanings, such as ‘moving light’ (*flash*, *flare*, *flame*), ‘falling or sliding movement’ (*slide*, *slither*, *slip*), ‘evoking sound’ (*cluck*, *click*, *clap*), ‘twisting’ (*twist*, *twirl*, *twinge*), ‘circular’ (*twirl*, *curl*, *whirl*), and ‘related to light or seeing’ (*glow*, *glance*, *glare*).

As Hinton, Nichols and Ohala (1994: 10) note, iconicity in spoken languages expresses “salient characteristics of objects and activities, such as movement, size, shape, color, and texture”. Thus, words that express perceptual concepts (e.g., *loud*, *rough*, and *bright*) should be more iconic than words for relatively more abstract and less perceptual concepts (e.g., *freedom*, *contract* and *disembodied*). In this study, we test this prediction in English, a language noted for its paucity of ideophones (e.g., Vigliocco et al., 2014). First we seek to replicate previous findings showing a relationship between the iconicity of words and their part-of-speech (Perry et al., 2015). We then look at differences in the iconicity of words between the five common senses and compare the results with Dingemanse’s ideophone hierarchy (2012).

Our study distinguishes iconicity – form-meaning resemblance – from systematicity, defined as any form of statistical regularity between phonological structure and meaning (Dingemanse et al., 2015; Monaghan, Shillcock, Christiansen & Kirby, 2014). For example, in forms such as *glitz* and *glisten*, there is no clear perceptual connection between the phonestheme *gl-* and shiny visual phenomena (Bergen, 2004; Cuskley & Kirby, 2013: 879–880). Systematicity is also evident in the sound structures of grammatical categories (Kelly, 1992). For example, English nouns and verbs have distinct phonological properties (Kelly, 1992; Farmer,

Christiansen & Monaghan, 2006). Crucially, systematicity has been investigated in a way that abstracts away from potential connections to sensory perception. Monaghan et al. (2014) merely look at correlations between meaning and form with no special regards to the precise content of those meanings (e.g., whether it is sensory or not). To better understand how iconicity and systematicity function together within a language, our analyses also examine and factor out the relationship between systematicity and the sensory properties of words.

2. Methods

2.1 Variables

Iconicity. We quantified iconicity based on native speaker ratings using the procedure of Perry et al. (2015) (see also Vinson, Cormier, Denmark, Schembri, & Vigliocco, 2008). Participants were given the following explanation of iconicity:

Some English words sound like what they mean. For example, SLURP sounds like the noise made when you perform this kind of drinking action. An example that does not relate to the sound of an action is TEENY, which sounds like something very small (compared to HUGE which sounds big). These words are iconic. You might be able to guess these words' meanings even if you did not know English. Words can also sound like the opposite of what they mean. For example, MICROORGANISM is a large word that means something very small. And WHALE is a small word that means something very large. And finally, many words are not iconic or opposite at all. For example there is nothing canine or feline sounding about the words DOG or CAT. These words are arbitrary. If you did not know English, you would not be able to guess the meanings of these words.

Participants were then asked to rate each word on a scale from -5 ("words that sound like the opposite of what they mean") to $+5$ ("words that sound like what they mean"). We supplemented Perry et al.'s (2015) norms for 592 words with an additional set of 2,409 English words. This set of 3,001 words with iconicity norms is the superset; the analyses presented below include different numbers of words depending on the overlap with different additional datasets.

To collect ratings for the 2,409 words that supplemented Perry et al.'s (2015) norms, we recruited 1,593 native speakers were recruited via Amazon Mechanical Turk. Each participant rated 25–26 words, which took approximately 4 minutes. Participants were paid 0.35 USD. The three words with the highest ratings were *humming* (4.47), *click* (4.46) and *hissing* (4.46). The three words with the lowest ratings were *dandelion* (-2.8), *silent* (-2.17) and *would* (-2.1).

Systematicity. Our measure of word systematicity comes from Monaghan et al. (2014). The systematicity for a set of 2,910 monosyllabic English words was determined by assessing each word's contribution to the overall form ~ meaning correlation (across all words). The three words with the highest systematicity were *wire* (0.0008), *tan* (0.0008) and *tramp* (0.0007). The three words with the lowest systematicity were *spume* (−0.001), *skimp* (−0.0008) and *splice* (−0.0007).

Sensory ratings. To test the connection between iconicity and the senses, we used several different norms for the sensory aspects of words. First, we used a measure from Juhasz and Yap (2013), who collected “sensory experience ratings”. In their study, sixty-three native English speakers rated whether a word “evokes a sensory experience” on a scale from 1 to 7. The instructions emphasized the five common senses: taste, touch, sight, sound and smell. The word with the highest sensory experience rating was *garlic* (6.56), followed by *walnut* (6.5) and *water* (6.33). The lowest sensory experience rating (1.0) was shared between many words, including *an*, *for* and *hence*. Words rated low in sensory experience were mostly function words, but also included some nouns, such as *choice* (1.0), *guide* (1.09) and *bane* (1.10).

We also included measures for two constructs that relate to “sensory experience” but that are not fully overlapping with it, namely “concreteness” (Brysbaert, Warriner & Kuperman, 2014) and “imageability” (Paivio, Yuille, & Madigan, 1968; Cortese & Fuggett, 2004). Although the instructions used to assess concreteness (Brysbaert et al. (2014) specifically mention each of the five senses, the instructions used to assess imageability, only mentioned “sensory experience, such as a mental picture or sound” (Cortese & Fuggett, 2004). Connell and Lynott (2012) found that concreteness and imageability ratings are biased towards the visual modality, at the expense of the other modalities. Hence, to the extent that iconicity may differ between words for vision and different perceptual modalities (hearing, touch etc.), we may expect to see differences between “concreteness” and “imageability” on the one hand and “sensory experience ratings” on the other. All results reported on imageability reported below held for norms from both Paivio et al. (1968) and Cortese and Fuggett (2004), with the latter reported in the main body of the text.

Sensory modality norms. Lynott and Connell (2009, 2013) measured the extent to which adjectives and nouns correspond to a particular sensory modality (e.g., vision) on a scale from 0 to 5. For example, a word such as *yellow* received a high visual score (average 4.9), but low scores for the other modalities (0 touch, 0.15 audition, 0.05 gustation, 0.05 olfaction). We also included sensory modality norms for verbs, using ratings obtained by Winter (2016a). There were 936 words with both modality norms and iconicity norms. In this paper, we used a discrete modality classification, with each word coded as belonging to one and only one

modality based on its highest-ranking perceptual strength measure. Based on this “dominant modality” measure, there were 590 visual words, 131 auditory words, 126 haptic words, 61 gustatory words and 28 olfactory words. The “dominant modality” classification is more informative for some words compared to others. The word *harsh*, for example, received high perceptual strength ratings for many sensory modalities but was classified as auditory in Lynott and Connell (2009). In the verb data from Winter (2016a), many abstract verbs of interaction, such as *to get*, were classified as “tactile” (see Winter, 2016b: Chapter 2 for discussion). Crucially, all our analyses reported below were also obtained by using the continuous ratings, where *to get* and *harsh* are not classified as “tactile” or “auditory”. For ease of understanding, our results focus on the dominant modality classification.

Frequency and part-of-speech data. We used word frequency data from the American SUBTLEX subtitle corpus of movie speech, as presented in the English Lexicon Project (Balota et al., 2007). Part-of-speech labels were taken from Brysbaert and Keuleers’ (2012) annotation of the SUBTLEX corpus.

Table 1 shows all the different datasets used across our analyses and their respective overlap with the main dataset, our iconicity norms.

Table 1. Overview of the different datasets used across the analyses presented in the paper, including the number of words that are also represented in the iconicity norms

	Reference	Words	Overlap with iconicity norms
Iconicity Norms	Perry et al. (2015) + this paper	3,001	–
Sensory Experience Ratings	Juhasz & Yap (2013)	1,779	59%
Word Frequency	Balota et al. (2007)	2,948	98%
Concreteness	Brysbaert et al. (2014)	2,820	94%
Imageability	Paivio et al. (1968), Cortese & Fuggett (2004)	1,697	57%/39%
Systematicity	Monaghan et al. (2014)	1,103	37%
Part-of-speech labels	Brysbaert & Keuleers (2012)	2,947	98%

2.2 Analyses

All analyses were conducted with R (R Core Team, 2015) and the packages “dplyr” (Wickham & Francois, 2015), “xlsx” (Dragulescu, 2015), “car” (Fox & Weisberg, 2011), “lsr” (Navarro, 2015) and “effsize” (Torchiano, 2015). All analyses used multiple regression to predict iconicity ratings from predictors such as part-of-speech, sensory experience ratings and concreteness. We did not fit interactions because we did not have specific hypotheses about particular interactions and because

we intended to use regression in a confirmatory rather than exploratory way. For all models reported below, variance inflation factors indicated no problem with (multi)collinearity and visual inspections of residual plots revealed no obvious violations of the normality and homogeneity of variance assumptions. All code and data are available on the following publicly accessible Github repository: http://www.github.com/bodowinter/iconicity_senses/

3. Results

3.1 Replication and extension of Perry et al. (2015)

We first sought to replicate the results of Perry et al. (2015) with the new expanded set. The average iconicity rating across all words was 0.92 ($SD = 1.13$), and a one sample t-test showed that this was reliably above zero¹ ($t(3000) = 44.29$, $p < 0.001$, Cohen's $d = 0.81$). Iconicity differed reliably between lexical categories ($F(6, 2940) = 44.82$, $p < 0.0001$, $R^2 = 0.08$). Figure 1 displays iconicity as a function of part-of-speech differences. Unsurprisingly, interjections and onomatopoeic words received the highest iconicity ratings ($M = 2.69$, $SD = 0.97$), e.g., *shhh* and *grr*. Following this, verbs received the next highest iconicity ratings ($M = 1.38$, $SD = 1.25$), then adjectives ($M = 1.18$, $SD = 1.1$) and adverbs ($M = 0.82$, $SD = 0.82$). Nouns received relatively lower iconicity ratings ($M = 0.69$, $SD = 1.04$). Grammatical words ($M = 0.48$, $SD = 0.85$) and proper names ($M = 0.46$, $SD = 1.03$) received the lowest ratings. These patterns replicate the basic findings from Perry et al. (2015). In contrast to the earlier study, the new part-of-speech tags include adverbs, which were found to be of intermediate iconicity. The adverbs in our set primarily included words with grammatical or discursive functions, such as *just*, *maybe*, *well*, *still*, *ever*, *quite* and *very*.

1. The finding that many words had iconicity ratings consistently higher than 0 suggests that native speakers have the intuition that many words sound like what they mean (see also Sutherland & Cimpian, 2015). This conclusion is possible because the scale we used allowed participants to also respond “sounds like the opposite of what it means”, i.e., the scale included a true zero.

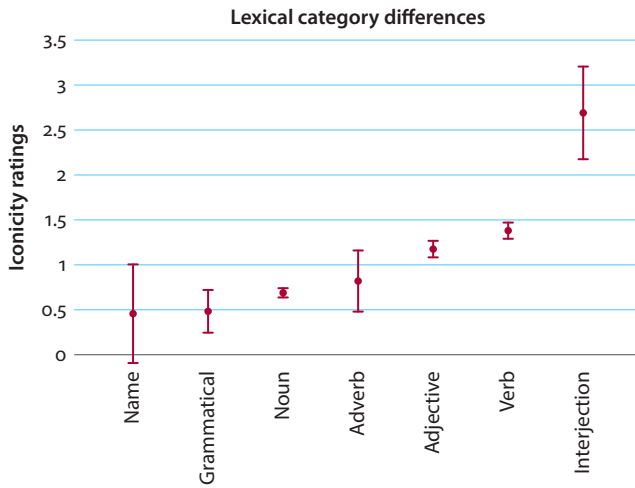


Figure 1. Iconicity by lexical category; points indicate linear model fits with 95% confidence intervals

3.2 Systematicity and iconicity

Next, we asked how our iconicity ratings compare to the systematicity index by Monaghan et al. (2014), which purely measures how much a word supports a correlation between form and meaning. Our iconicity ratings overlapped with 1,104 of these words (37% of our total iconicity norms). The iconicity ratings and the systematicity index were weakly correlated with each other ($r = 0.06$, $t(1101) = 2.06$, $p = 0.04$). The low correlation suggests that systematicity and iconicity tap mainly into different underlying constructs, a point that is also made by additional analyses presented below.

3.3 Sensory meanings and iconicity

Are more highly perceptual words more prone to iconicity? We approached this question using the sensory experience ratings from Juhasz and Yap (2013). We constructed a linear model with iconicity ratings as the main dependent measure and sensory experience ratings, concreteness, imageability, systematicity and log frequency of the word as predictors² (all z-scored to allow for easy comparison of predictors). Figure 1 shows a plot of iconicity residuals as a function of sen-

2. An initial model showed that concreteness ratings were not reliably associated with iconicity ratings ($t(975) = 0.52$, $p = 0.6$) and caused multicollinearity issues (variance inflation factors above 4). Because of this, and because concreteness taps into a similar concept to imageability (Connell & Lynott, 2012), concreteness was dropped from the model.

sory experience, while controlling for all other remaining variables (frequency, imageability, systematicity). As shown in Figure 2, words higher in sensory experience had higher iconicity ratings. Together, imageability, systematicity, frequency and sensory experience ratings described 21% of the variance in iconicity ratings (adjusted R^2). Sensory experience ratings alone described 13% of variance in iconicity ratings.³



Figure 2. Relationship between iconicity ratings and sensory experience ratings after controlling for frequency, imageability and systematicity; the solid line indicates linear model fit with the shaded area indicating the 95% confidence region

Table 2 shows the standardized coefficients of the regression model. Systematicity was the only variable not correlated with iconicity ($b = 0.05$, $SE = 0.03$, $t(984) = 1.53$, $p = 0.13$). Thus, the weak correlation between iconicity and systematicity reported above went away once imageability, frequency and sensory experience are incorporated into a more complex model. Both imageability ($b = -0.39$, $SE = 0.04$, $t(984) = 10.53$, $p < 0.0001$) and frequency ($b = -0.26$, $SE = 0.04$, $t(984) = 6.72$, $p < 0.0001$) were negatively associated with iconicity. Of all predictors considered here, sensory experience had the strongest relationship with iconicity ($b = 0.52$). The negative relationship between word frequency and iconicity ratings stems from using word frequency data based on adult language. Perry and colleagues (submitted) showed that adults use iconic words less frequently in adult-directed speech compared to child-directed speech. The negative relationship between imageability and iconicity ratings suggests that relatively more visual meanings are relatively less iconic (controlling for overall sensory experience across modalities).

3. R^2 values may vary in different models due to different number of data points (missing values) in different models. The lowest R^2 value for sensory experience, 7%, is obtained in a model with only sensory experience as a predictor.

Table 2. Standardized regression coefficients (predicting iconicity ratings) for the multiple regression model visualized in Figure 1

	Coefficient	SE	<i>t</i>	<i>p</i>
Sensory Experience	0.52	0.04	12.39	< 0.0001
Imageability	-0.39	0.04	10.53	< 0.0001
Frequency	-0.26	0.04	6.72	< 0.0001
Systematicity	0.05	0.03	1.53	0.13

We repeated the above analysis with systematicity as dependent measure, and sensory experience, frequency and imageability as predictors. In contrast to iconicity, sensory experience was not related to systematicity ($b \approx 0$, $t = 0.96$, $p = 0.34$). Frequency ($b = -0.000014$, $SE = 0.0000047$, $t = 2.95$, $p = 0.003$) and imageability ($b = -0.00001$, $SE = 0.000005$, $t = 2.45$, $p = 0.015$) were reliably associated with systematicity, but the coefficients were trending towards 0 and the described variance of the overall model was found to be extremely low ($\sim 1\%$). These analyses reinforce the notion that systematicity is distinct from iconicity (Dingemanse et al., 2015).

3.4 Modality differences in iconicity

We next assessed the connection between iconicity and particular sensory modalities, using the norms collected by Lynnot and Connell (2009, 2013) and Winter (2016a). A linear model with iconicity norms as the dependent measure and part-of-speech, frequency and dominant modality as predictors revealed a reliable effect of frequency ($b = 0.09$, $SE = 0.04$, $t(837) = 2.33$, $p = 0.02$), part-of-speech ($F(2, 837) = 94.01$, $p < 0.001$) and crucially, sensory modality ($F(4, 837) = 35.1$, $p < 0.001$). Figure 3 shows the predicted means per modality (linear model fits) with 95% confidence intervals. Visual words had the lowest iconicity ratings, with a mean rating of 0.7 ($SD = 0.93$). Olfactory ($M = 0.82$, $SD = 0.88$) and gustatory words ($M = 0.9$, $SD = 1.04$) had somewhat higher ratings. Words in the tactile ($M = 1.54$, $SD = 1.02$) and auditory ($M = 1.59$, $SD = 1.39$) modalities had the highest iconicity ratings. The full model described 28% of the variance in iconicity ratings, of which the “dominant modality” factor described 11% of unique variance. A similar model with systematicity as the dependent measure revealed no reliable by-modality differences ($F(4, 262) = 0.28$, $p = 0.89$). No variance was described by the “dominant modality” factor when predicting systematicity instead of iconicity (adjusted $R^2 = -0.01$), showing that there were no reliable differences between modalities in systematicity.

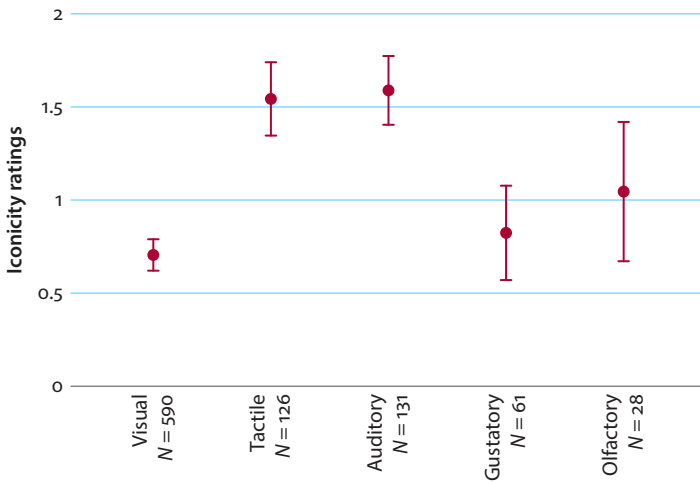


Figure 3. Iconicity by sensory modality (modality data are from Lynott & Connell, 2009, 2013; Winter, 2016a); points indicate linear model fits with 95% confidence intervals

The results were similar when the continuous modality strength ratings were used instead of the dominant modality classification. Using separate models for each modality (to avoid collinearity), there was no statistically reliable association between iconicity norms and visual strength ratings ($b = -0.03$, $SE = 0.03$, $t = -0.9$, $p = 0.38$, $R^2 \approx 0$) or gustatory strength ratings ($b = 0.007$, $SE = 0.03$, $t = 0.26$, $p = 0.8$, $R^2 \approx 0$). There was a reliable *negative* association between iconicity and olfactory strength ratings ($b = -0.09$, $SE = 0.03$, $t = -3$, $p = 0.002$, adjusted $R^2 \approx 0$). And there were reliable *positive* associations between iconicity and auditory strength ($b = 0.09$, $SE = 0.03$, $t = 3.53$, $p = 0.0004$, $R^2 \approx 0.01$) and between iconicity and tactile strength ($b = 0.09$, $SE = 0.03$, $t = 3.39$, $p = 0.0007$, $R^2 \approx 0.01$). Taking the *maximum* perceptual strength rating for each word (across all modalities, following Connell & Lynott, 2012), there was a positive association with iconicity norms (controlling for frequency) ($b = 0.39$, $SE = 0.046$, $t = 8.47$, $p < 0.0001$, $R^2 \approx 0.08$). This replicates the results obtained for sensory experience ratings reported above (Juhasz & Yap, 2013) with a different dataset, the modality norms.

Table 3 shows the most iconic and least iconic words for each modality. The most iconic words for the auditory modality all had onomatopoetic qualities, such as *squealing*, *muffled*, and *banging*. Many of the most iconic words in the tactile modality contained recognized phonesthemes. For example, two of the most iconic words (*crash*, *crisp*) contained the phonestheme *cr-*, which has several meanings listed in Hutchins (1998, Appendix A), among them ‘clumsy, cloggy, ungainly, sticky’ (from Firth, 1930), ‘crooked, opposite of straight’ (from Firth, 1935), and ‘harsh or unpleasant noises’ (from Marchand, 1959). Interestingly, many of the olfactory words that ranked high in iconicity were verbs, and they also contained

recognized phonesthemes, namely the initial *sn-* cluster, listed by Firth (1930: 58) as referring to ‘nasal’ meanings (*sniff*, *snout*, *sneeze*), and the final *-iff* phonestheme, listed by Marchand (1960: 336, cited in Hutchins, 1998) as referring to ‘noise of breath or liquor’ (*to sniff*, *whiffy*). Thus, iconicity in the olfactory domain does not appear to relate to specific odors, but rather to smell-related actions, which is in line with the cross-linguistic tendency of words denoting ‘nose’ to contain nasal phonemes (Blust, 2003; Wichmann, Holman & Brown, 2010; Urban, 2011; Blasi, Wichmann, Hammarström, Stadler, & Christiansen, 2016).

Table 3. Examples of words with high and low iconicity ratings per modality

	High iconicity ratings	Low iconicity ratings
Auditory	<i>hissing, buzzing, clank</i>	<i>silent, soundless, permission</i>
Tactile	<i>mushy, crash, crisp</i>	<i>weightless, get, try</i>
Olfactory	<i>sniff, whiff, whiffy</i>	<i>scentless, antiseptic, scent</i>
Gustatory	<i>juicy, suck, chewy</i>	<i>palatable, unpalatable, cloying</i>
Visual	<i>murky, tiny, quick</i>	<i>statement, quality, route</i>

We further examined the relationship between modality and phonesthemes using the data set of Hutchins (1998, Appendix A), which lists hundreds of phonesthemes for the English language based on an extensive literature review. This list was matched to all adjectives, which revealed that auditory words had the highest proportion of words with phonesthemes (63%), followed by tactile words (36%), visual words (22%), gustatory words (19%) and olfactory words (7%). A simple Chi-Square test showed that there are significant by-modality differences in phonestheme counts ($\chi^2(4) = 57.4, p < 0.0001$).

4. Discussion

We examined the iconicity of 3,001 English words. Using native speaker ratings of iconicity in combination with sensory norms, we analyzed the distribution of iconicity across visual, auditory, gustatory and olfactory concepts. We found that some portions of the English vocabulary were far more iconic than others. Our results generally replicated the findings from Perry et al. (2015): onomatopoeia and interjections were most iconic, which were followed by verbs and adjectives, which were more iconic than nouns, adverbs and grammatical words. Notably, we also found that the iconicity of words related directly to their semantics. Words that refer to perceptual content (higher sensory experience ratings) were particularly high in iconicity. We furthermore found that, within the set of highly sensory

words, those that denote auditory and tactile meanings were particularly high in iconicity compared to those denoting visual, olfactory and gustatory meanings.

The relationship between iconicity and the senses was independent of systematicity (Monaghan et al., 2014; Dingemanse et al., 2015). Our analyses showed that the iconicity we investigated via our norms is distinct from the correlational form-meaning correspondences captured by Monaghan et al.'s (2014) measure. In contrast to our iconicity norms, systematicity did not correlate with sensory experience ratings, and it did not show any reliable pattern of differences by modality. Moreover, systematicity and iconicity were only weakly correlated with each other, and that correlation ceased to be statistically reliable once other variables were controlled for. These results show that iconicity and systematicity are at least partially independent properties of English words, and that iconicity exhibits stronger ties to sensory imagery.

The observed effects of sensory modality on rated iconicity were supported by phonestheme counts, which showed that touch and sound words had relatively more phonesthemes than visual, gustatory and olfactory words. Cuskley and Kirby (2013:880) contrast what they call "conventional" sound symbolism with "synesthetic" or "sensory" sound symbolism, and they note that phonesthemes "must be classed as conventional rather than sensory sound symbolism" (Cuskley & Kirby, 2013:880). The present results suggest a stronger connection between phonesthemes and sensory meanings than Cuskley and Kirby (2013)'s dichotomy would suggest. In particular, sound words contain many more phonesthemes than words for the other modalities, which Rhodes (1994) argues is rooted in direct sound-to-sound associations. Our results show that even though phonesthemes may be conventional, they are also frequently associated with sensory meanings.

Our results focus on English, but the observed patterns fit with a broader pattern found in studies of ideophones. To some extent, our results mirror the hierarchy of ideophone semantics described Dingemanse (2012) (see above). In particular, auditory concepts – which are most commonly expressed by ideophones – were found to be the most iconic in our analyses as well. This intuitive result reinforces the idea that the vocal-acoustic medium of spoken languages readily affords the expression of concepts from the domain of sound (Dingemanse et al., 2015; Perlman & Cain, 2014). Notably, this stands in contrast to signed languages in which iconicity gravitates towards visual meanings (see words listed in Vinson et al., 2008). Thus, these results support the general principle that iconicity is greatest when encoding sensory meanings in the same modality (e.g. Dingemanse, et al., 2015; Perlman & Cain, 2014).

We also found a high level of iconicity in the tactile modality. Our finding that words in the tactile modality were high in iconicity fits with reports of many languages that have dedicated touch ideophones, including Japanese (Imai, Kita,

Nagumo, & Okada, 2008; Watanabe et al., 2012: 2518; Watanabe & Sakamoto, 2012; Yoshino, Yakata, Shimizu, Haginoya, & Sakamoto, 2013) and several African languages (e.g., Dingemanse, 2011a; 2011b; Dingemanse & Majid, 2012; Essegbey, 2013). Experimental studies have also found evidence for a close between sound and the sense of touch. For example, Fryer et al. (2014) showed that when blindfolded participants haptically explored spiky or rounded shapes, they associated the pseudoword *kiki* with spiky and *bouba* with round shapes. And Etzi et al. (2016) showed a similar effect for rough and smooth surfaces (see also Fontana, 2013). Together with these previous studies, our findings support the idea that next to audition, touch is highly expressible via speech.

The high level of iconicity in the tactile modality may be explained by several factors. First, there is a large literature which shows that in sensory perception, audition and touch are tightly integrated (Jousmäki & Hari, 1998; Guest, Catmur, Lloyd, & Spence, 2002; Suzuki, Gyoba, & Sakamoto, 2008; Schürmann, Caetano, Jousmäki, & Hari, 2004), including evidence that some neurons directly respond to both somatosensory and auditory stimuli (Schroeder, Lindsley, Specht, Marcovici, Smiley, & Javitt, 2001). These neural and cognitive ties between audition and the tactile modality might make it particularly likely that people perceive correspondences between speech sounds and touch. A second meeting point for the two modalities is that humans explore the haptic properties of surfaces in a dynamic fashion. Bartley (1953: 401) notes that “tactile exploration is a piecemeal affair” and Carlson (2010: 248) mentions that “[u]nless the skin is moving, tactile sensation provides little information about the nature of objects we touch.” Speech is similar in that it is drawn out over time. Thus, the temporal properties of touch perception may be more mappable to the temporal domain of speech, compared to relatively more static sensory domains, such as color. Notably, the intrinsically dynamic domain of movement also ranks fairly high in Dingemanse’s ideophone hierarchy, see (1). The finding that verbs are relatively more iconic than nouns (at least in English, Perry et al., 2015) is also in support of a special role for dynamicity in correspondences between speech sounds and the senses.

Words denoting meanings in modalities other than touch and audition – vision, taste, and smell – were lower in iconicity. These results may reflect that these kinds of meanings do not so readily afford iconic representation in the form of spoken words. For gustatory and olfactory meanings, this conclusion fits with research showing that these modalities are also expressed less commonly in ideophones across languages. However, it was the visual modality that emerged as the least iconic, and this seemingly contradicts the ideophone hierarchy, which lists “visual patterns” above “other sensory perceptions”. One explanation for this discrepancy may be that our list of visual words contained a large number of static

object properties, such as *dirty*, *wide* and *square*, as well as many color terms (which generally received low iconicity ratings), such as *yellow*, *pink* and *blue*.

The fact that vision ranks so low on our iconicity norms is perhaps unexpected given the dominance of the *kiki-bouba* paradigm in experimental research (for a review, see Lockwood & Dingemanse, 2015), which is often taken to be a mapping between sound and visual shape. However, one should not forget that shape can be perceived through multiple sensory modalities (Marks, 1978), including touch and sound. When people see the spiky shapes that are associated with nonce words like *kiki*, it is not clear what specific sensory modality is involved, e.g., whether it is imagining what a *kiki* shape sounds like when it falls onto the ground or how it feels when it is touched. The present results also highlight that one should be careful when generalizing results from nonce words to language structure: The particular semantic domain of iconicity investigated in a lab context (e.g., the shapes associated with *kiki/bouba*) may not be the most prevalent domain in natural languages. Our present results suggest a stronger role for touch-based and sound-based iconicity than is suggested by previous lab results.

5. Conclusion

It is often assumed that the visual medium of signed languages affords drastically more iconicity than the auditory medium of spoken languages (Meir et al., 2013; Armstrong & Wilcox, 2007). However, with the emerging understanding that languages in any modality exhibit a balance between iconicity and arbitrariness (Dingemanse et al., 2015), it is critical to understand the nature of this balance and how this relates to the modality of language. In line with this view, our study illustrates how questions about iconicity cannot be separated from questions about sensory perception. Our results show how the English vocabulary exhibits “pockets of iconicity” in particular semantic domains. When a semantic domain readily affords iconic mappings, words referring to concepts from that domain are more likely to be expressed with iconic forms. Importantly, this appears to be a general principle of languages, true for spoken and signed languages alike.

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