

**Title**

Arbitrariness, iconicity and systematicity in language

**Authors**

Mark Dingemans<sup>1</sup>, Damián E. Blasi<sup>2,3</sup>, Gary Lupyan<sup>4</sup>, Morten H. Christiansen<sup>5,6</sup>, Padraic Monaghan<sup>7</sup>

<sup>1</sup> Max Planck Institute for Psycholinguistics

<sup>2</sup> Max Planck Institute for Mathematics in the Sciences

<sup>3</sup> Max Planck Institute for Evolutionary Anthropology

<sup>4</sup> University of Wisconsin-Madison

<sup>5</sup> Cornell University

<sup>6</sup> University of Southern Denmark

<sup>7</sup> Lancaster University

**Corresponding author**

Dingemans, Mark (mark.dingemans@mpi.nl)

Language & Cognition Department

Max Planck Institute for Psycholinguistics

PO Box 310, 6500 AH, Nijmegen, The Netherlands

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### Abstract

The notion that the form of a word bears an arbitrary relation to its meaning accounts only partly for the attested relations between form and meaning in the world's languages. Recent research suggests a more textured view of vocabulary structure, in which arbitrariness is complemented by iconicity (aspects of form resemble aspects of meaning) and systematicity (statistical regularities in forms predict function). Experimental evidence suggests these form to meaning correspondences serve different functions in language processing, development and communication: systematicity facilitates category learning by means of phonological cues, iconicity facilitates word learning and communication by means of perceptuomotor analogies, and arbitrariness facilitates meaning individuation through distinctive forms. Processes of cultural evolution help explain how these competing motivations shape vocabulary structure.

### The return of non-arbitrariness

An upheaval is underway in current thinking about the arbitrary nature of linguistic signs. The long-standing view that the form of a word has an essentially arbitrary relation to the word's meaning [1,2] is giving way to a perspective that recognises roles for both arbitrariness and non-arbitrariness in language. Recent research from across the cognitive sciences is revealing substantial patterns of non-arbitrariness in the vocabulary and investigating mechanisms for how it comes about. This review traces two recent developments that are key in enabling a paradigm change: (1) our access to linguistic facts has changed, revealing that forms of non-arbitrariness are more widespread than previously assumed; and (2) our understanding of the mechanisms underlying the distribution of arbitrary and non-arbitrary aspects of language structure is rapidly advancing, spurred on by innovations in methods and theory. These developments are already making an impact in the study of language and mind. Here we aim to capture the momentum in the field, clarify conceptual distinctions, and review methods and mechanisms that are important for future work in this domain.

Linguistic inquiry often begins with idealised conceptions in an effort to understand theoretically interesting properties of language. For instance, to explain the seemingly unlimited expressive power of language, a reasonable starting assumption might be that the relation between form and meaning in words is arbitrary and therefore unconstrained: any combination of sounds can signify any meaning [2,3]. As understanding advances, idealised conceptions give way to more refined models of language form and language function, and recent theoretical insights have led to distinctions in the ways in which words are non-arbitrary. Studies on non-arbitrariness in terms of morphological structure, syntactic and discourse structure, have highlighted numerous correspondences between meaning and linguistic form [4–6]. Similarly, research on sign languages and gestural communication accompanying spoken language offers flourishing fields for exploring non-arbitrariness in language processing and communication [7–10]. Our focus here, however, is on spoken language vocabulary, as this is where arbitrariness in language structure has most frequently been described. Furthermore, this is where, at the current state of knowledge, distinct forms of non-arbitrariness can be linked most clearly to the differential roles of arbitrary and non-arbitrary relations in language learning and language processing.

## Types of non-arbitrariness and their distribution

The vocabularies of spoken languages furnish many examples of arbitrariness. That tree is *arbre* in French and *Baum* in German illustrates how many form-meaning mappings arise more by communal convention than as a result of some intrinsic connection between form and meaning. Yet counterexamples are never far away. Particularly oft-cited (and as frequently dismissed because they seem marginal) are onomatopoeia like *bang* or *woof*. There are, however, risks of cherry-picking and case-based reasoning from such examples, which can be avoided through a comprehensive view and quantitative analyses of the structure and diversity of vocabularies and natural languages.

The world's languages are highly diverse, from modality (spoken and signed) to the number and magnitude of basic lexical categories [11–13]. For an adequate account of non-arbitrariness, it is not sufficient to look at one language, or one part of the vocabulary: a broad, cross-linguistic perspective is called for. Furthermore, in order to appraise the occurrence of non-arbitrary relations found across natural languages, at least two kinds of non-arbitrariness — iconicity and systematicity (Box 1 and Figure 1) — must be distinguished. We start by tracing cross cross-linguistic evidence for the distribution of these non-arbitrary structures in the vocabularies of natural languages.

### Iconicity

A prominent form of non-arbitrariness is *iconicity*, in which aspects of the form and meaning of words are related by means of perceptuomotor analogies. Onomatopoeic words such as English *woof* and *bow wow* or Japanese *wan wan* (imitative of the sound of a dog barking) offer familiar examples. The diversity of forms even in onomatopoeia for similar sounds shows that different perceptual aspects of a referent may be imitated. Additionally, language-specific phonological constraints can introduce further cross-linguistic differences. These iconic words are thus shaped by competing motivations of obeying phonological constraints while maximising perceptual similarity between form and meaning [14,15].

Iconicity in spoken language can go beyond the imitation of sound by recruiting other aspects of the speech signal (e.g., temporal unfolding, intensity, and articulatory dynamics) to depict aspects of meaning [16–18]. This is seen most clearly in *ideophones* (also known as expressives or mimetics), vivid sensory words that are widespread and numerous in the languages of Africa, Asia and the Americas [19,20]. Ideophones are words like *kibikibi* ‘energetic’ and *bukubuku* ‘flabby, obese’ in Japanese or *fwefwefwe* ‘springy, elastic’ and *saaa* ‘cool sensation’ in Siwu, a language spoken in Ghana. Some of the cross-linguistically recurrent iconic patterns found in ideophones include repeated forms depicting repeated or iterative events, contrasts between vowels like [i:a] depicting analogous contrasts in magnitude, and voicing contrasts like [k:g] depicting contrasts in intensity [21–23] (Table 1). Claims concerning the iconicity of such words [24,25] have found increasing empirical support, for instance in behavioural experiments showing that people who have no prior knowledge of Japanese (a language rich in ideophones) can match Japanese ideophones with their correct meanings at an above chance level of accuracy [26,27]. Moreover, corpus studies of Tamil and Japanese have shown that within comparable semantic domains, ideophones are more similar in form to one another than nouns [8], suggesting ideophones are less arbitrary and more iconic than nouns.

Evidence from spoken and signed languages shows that iconicity is not a binary property, but comes in different types and degrees [8,9]. One broad distinction is between ABSOLUTE ICONICITY, which involves a fairly straightforward one-to-one resemblance between aspects of form and meaning (as in onomatopoeia), and RELATIVE ICONICITY, in which relations between multiple forms resemble analogical relations between meanings, as in many ideophones (Figure 1e). Relative iconicity is also sometimes called diagrammatic iconicity, highlighting the fact that iconic words —in spoken as well

as signed languages— can be seen as ‘diagrams’ that provide schematic structural correspondences between forms and meanings [28,29]. Finer-grained distinctions can also be made (e.g., based on whether a sign depicts a referent directly or by means of an action done with that referent [30], or based on whether iconic correspondences are within one modality or across modalities). All types of iconicity involve perceptuomotor analogies between aspects of form and meaning.

### *Systematicity*

A different form of non-arbitrariness is systematicity, a statistical relationship between the patterns of sound for a group of words and their usage. Although individual items in core lexical classes may appear arbitrary, corpus studies reveal subtle phonological and prosodic cues—like vowel quality, syllable duration and stress—that help distinguish nouns from verbs [31] and open from closed word classes [32], and that may even correlate with semantic factors like concreteness [33]. These are examples of systematicity, a pervasive form of non-arbitrariness that has flown under the radar so far because it is not about the relation of single words to simple referential meanings but of large numbers of words to a limited number of abstract categories (Figure 1c,d).

Corpus analyses have shown that such category-level cues are found in a range of languages including English, French, Dutch and Japanese [34], and there is tentative typological evidence for similar patterns in a broader range of languages and word classes [35]. In systematicity, the exact nature of the cues typically language-specific: the cues distinguishing nouns from verbs in English are different from those distinguishing nouns from verbs in Japanese (Table 3 and Figure 1d). These cross-linguistic differences can exist because unlike iconicity, systematicity does not require perceptuomotor analogies between form and meaning; large-scale distributional regularities suffice. Given exposure to enough words, subtle statistical differences in word forms help listeners and learners identify grammatical categories [36].

The pervasive patterns of systematicity discussed so far pertain to simple, monomorphemic words. Of course, many lexical items are composed of several morphemes, providing another pervasive source of systematicity [37]. Morphologically complex lexical items combine arbitrary aspects with systematic relations to other items in the system. For instance, a verb (*teach*) and a morpheme *-er* combine to form a semantically-related noun (*teacher*); and a compound noun like *oak tree* indicates a relation to *tree*, *oak wood*, et cetera. Vocabulary structure owes much to the myriad webs of relationships established by this form of systematicity, which is widespread even in relatively morphologically impoverished languages like English, and which is known to impact learning and categorization [38,39]. As with category-level systematicity, while the patterns are regular and non-arbitrary, the cues themselves are language-specific (e.g., there is nothing about the form of *-er* that is suggestive of its meaning), a fact reflected in de Saussure’s term, *relative arbitrariness* [1].

### *Differential distribution of iconicity and systematicity*

There are important differences in the distribution of iconicity and systematicity over the vocabulary and across languages [40]. Category-level systematicity is pervasive and supported by multiple subtle cues whose ultimate form is language-specific (Figure 1d). Iconicity is generally less pervasive, as it can only achieve prominence in those parts of vocabulary that permit iconic correspondences between form and meaning; yet where this is possible, iconic patterns are likely to recur across languages as they are grounded in structural similarity (Figure 1e). This means that language-specific distributional regularities are likely instances of systematicity, whereas form-meaning mappings that recur across languages and rely on perceptual analogies are likely instances of iconicity.

The distribution of iconicity is further shaped and constrained by the affordances of meaning and modality [41,42]. This explains why in spoken languages, we find ideophones especially in the domain of perceptuomotor meanings (where aspects of sound, motion, visual patterns, temporal unfolding and other percepts can be mimicked by properties of the speech signal [20]); and why in signed languages, we find many iconic signs in the domains of motion, shape and spatial relations [7] (Table 3). The modality-dependence of different types of non-arbitrariness is a major topic of current and future research [43] (see Outstanding Questions).

Linguistic descriptions are increasingly being complemented by large-scale comparisons of lexical databases to detect more subtle convergences in the use of specific phonological resources for comparable items in the vocabulary. Such analyses have revealed magnitude symbolism in the languages of Australia [44], non-arbitrary patterns in spatial demonstratives in 101 languages of 30 language families [45], and subtle sound-meaning associations in basic vocabulary in about half of the world's languages [46], many of which remain robust even when controlling for phylogeny and geography [47]. Those conducting such work face the important challenges of defining what counts as a non-arbitrary sound-meaning association, distinguishing systematic and iconic associations, and teasing apart independent innovations from patterns inherited from related languages (i.e., Galton's problem [48]). Future work meeting these challenges can shed light on the historical dynamics of patterns of non-arbitrariness in vocabulary, for instance by testing proposals that iconic or sound-symbolic words grow in clusters and that they may evade regular sound changes [49,50].

### **Causes and mechanisms**

Why do different types of form to meaning correspondences pattern the way they do in vocabulary, and what are the consequences of this patterning for understanding the structure of language and the human mind? We review converging evidence that arbitrariness, systematicity and iconicity coexist in vocabularies because they serve distinct, complementary functions [8,9], and we consider some of the processes of cultural evolution by which they may come to spread and persist.

#### *Systematicity assists category learning and categorisation*

Individuating particular referents and linking words to them is only one of the many challenges for language learners. Another important task is to use those words in the context of larger utterances and to learn whether they should be used as nouns, verbs or something else. As seen above, grammatical distinctions may be reflected in subtle prosodic and phonological cues or in overt morphological structure, two important forms of systematicity. Children learn nouns and verbs better if there is a systematic correspondence between the sounds of the words and their respective grammatical categories [36,51]. This advantage extends to novel words constructed to show systematic relations between form and meaning [52]. Thus, systematicity provides important benefits for learning sound-category distinctions.

How does systematicity relate to and coexist with other form to meaning correspondences? Different divisions have emerged in the vocabulary to meet the competing requirements of individuating particular referents of words and categorizing sets of words according to their grammatical classes [53]. First, the vocabulary is divided within the word, such that different sublexical regions of the word may address the different tasks. For example, infinitive verb forms in Spanish have characteristic -ar/-er/-ir endings that help mark them as verbs, while the initial part is more arbitrary. It has been suggested that there might be a processing related pressure towards arbitrariness at the beginning of words because memory load will be minimized when the referent of a word can be identified as quickly as possible [54]. This may partly explain the suffixing preference

across the world's languages [55, but see 56 for an alternative view]: the fact that individuating, arbitrary information tends to occur earlier than shared, systematic information such as broad semantic distinctions and grammatical roles [57]. A second way in which the vocabulary is divided is chronologically over the learner's lifespan. In English, the degree to which individual words show non-arbitrariness was predicted by the age-of-acquisition of the word [40]. Those words acquired earlier in development tended to show less arbitrariness within the language, whereas those words acquired later were more arbitrary (the methods used in this study do not allow inferences about the systematic or iconic nature of these patterns). Thus, the extent to which the words that children first acquire are different or similar in their phonological properties reflects the extent to which they are similar or different in their meaning.

This division addresses two competing requirements for spoken words in supporting language learning. Early in language development, systematicity may be beneficial as the regularities in the mapping between representational spaces in different modalities can be exploited. However, with vocabulary growth, representational spaces comprising forms and meanings become more densely populated, thereby increasing the possibilities of confusion and ambiguity in the spoken forms of words, providing a selective pressure towards more arbitrary, more discriminable forms. Intriguingly, further links between age of acquisition and non-arbitrariness have been observed in other studies. For instance, there is a significant correlation between subjective ratings of iconicity and age-of-acquisition in English and Spanish [58], as well as in British Sign Language [59]: earlier acquired signs are more iconic. Production experiments reveal how systematic differences in the patterning of iconic strategies in sign languages and in the gestures of non-signers may come to indicate a noun-verb distinction, perhaps similar to the phonological cues supporting systematicity in spoken languages [60]. Further work is necessary to tease apart the different but potentially overlapping contributions of systematicity and iconicity in this domain, and to see how these observations extend to typologically diverse spoken and signed languages.

#### *Iconicity assists word learning and communication*

As linguist and psychologist Karl Bühler observed long ago, a language consisting only of iconic words could never meet all our communicative needs [61] because the possible form-meaning correspondences are more constrained for iconic words than for arbitrary ones. However, flanked by arbitrariness and systematicity, iconicity offers some important advantages.

To understand how iconicity may be beneficial in learning and communication, it is useful to consider the mechanisms that make iconic form-meaning correspondences possible. Some may rely on structural correspondences between aspects of meaning and the spectral or articulatory patterns of words [18,29,62]. Some may reflect common neural coding across distinct sensory modalities [63,64], as in the association of pitch and luminance [65,66]. Another mechanism that may contribute to cross-modal iconicity is general perceptual learning [67,68]. Objects made of certain materials make certain sounds when dropped, larger dogs produce a lower pitch bark, movements have predictable temporal unfolding, and such regularities may be tapped into by iconic words. What unites these mechanisms is the fact that they highlight and construe perceptuomotor analogies.

The power of perceptuomotor analogies in learning and communication is well-known. Iconic gestures and other visual representations crucially support generalisation and explanation in many areas of life, from explaining everyday actions to complex mathematics and pain sensations [69–71]. Iconic gestures accompanying speech are found to enhance comprehension [72,73] by highlighting perceptuomotor information and by supplying information not present in arbitrary words [74,75]. Such advantages likely extend to iconic words in the vocabulary. Some of the clearest evidence from

this comes from sign language. Thus, signs in British Sign Language that are judged to be more iconic are recognised more quickly and reproduced with higher accuracy than signs that are less iconic [76,77], and these advantages extend to second language learners [78,79].

In spoken language, iconicity has similarly been suggested to provide an advantage in conveying sensory information. For instance, English speaking children learned words in the domain of motor actions better when the words matched existing Japanese ideophones [80,81]. Studies of ideophone use emphasise their communicative utility in context ranging from participatory learning to patient-doctor interaction [82,83]. Neuroimaging studies suggest that ideophones activate sensori-motor representations more strongly than arbitrary words [84] and nonwords [85], supporting the thesis that ideophones, like iconic gestures, may assist communication by creating perceptual analogies and conveying perceptuomotor information.

A prolific area of research investigates the possibilities and limits of such iconic form-meaning mappings through behavioural experiments involved controlled nonwords [86]. The best known examples come from studies showing that people consistently match rounded and angled shapes to novel words like “baluma” and “tukeetee”, or “bouba” and “kiki” respectively [87–89]. Infant studies suggest that these effects are not due to orthography or prior linguistic experience [90,91], and studies of special populations reveal possible disruptions, contributing to our understanding of the neurological roots of cross-modal iconicity [92,93]. Many of these studies have relied on forced-choice methods with nonword pairs constructed for maximal contrasts, which provides a reason for caution in interpreting the results [52]. Recent work, however, has shown similar effects using different types of tasks (including implicit interference, attribute-listing and categorisation, and iterated learning [94–96]) and a broader range of stimuli (e.g., randomly generated or systematically selected visual and auditory materials [97–99]). Not only can iconic words be easier to learn [100], but they can facilitate people’s ability to learn to home in on perceptual differences that distinguish novel categories [95]. This work shows that the communicative advantages of iconicity may extend to learning, communication, and categorization, especially in domains where perceptual relations between words and meanings can be made salient by iconic mappings.

#### *Advantages of arbitrariness*

Given the apparent advantages of iconicity and systematicity, one might wonder why language is as arbitrary as it is. Indeed philosophers from Plato’s *Cratylus* onward have tended to view arbitrary relations between words and meanings as a shortcoming, striving to create artificial languages in which each word was “naturally” related to its referent [101,102]. Arbitrariness, however, has some key advantages to communication.

First, some degree of arbitrariness appears necessary to attain flexibility in signaling. Many animal communication systems have a small and rigid set of holistic signals for a few relevant situations [103,104]. In the transition from such a system to the complexity and flexibility of language, a crucial step is to allow decoupling of the direct, one-to-one linkage between form and meanings and start using signals and parts of signals as discrete building blocks, allowing *duality of patterning* [2,105,106]. (The evolutionary origins of language remain a topic of intense debate, and recent work points to the involvement of gesture as well as speech, with complementary roles for iconicity and arbitrariness [9,107].) Second, and moving to more immediate communicative advantages, arbitrariness allows us to communicate about concepts for which direct perceptual grounding is unlikely to be available [108]. Third, in a fully iconic and systematic language, similar meanings would be expressed using similar forms—a situation that, on its own, would lead to high confusability of the very items in most need of differentiation. Experimental studies show that systematicity can be

an impediment to telling apart distinct referents, which is facilitated by arbitrariness [53]. A recent survey comparing arbitrariness and iconicity proposes arbitrariness is adaptive because it renders linguistic signals “efficient and discriminable” [9]. Fourth, studies of the cognitive functions of language have shown that arbitrary labels facilitate learning of type/token distinctions (e.g., the general concept DOG versus a specific instance of a dog such as *Fido*) [109], and in comparison to iconic expressions, are more effective at activating such conceptual states [110,111], possibly because iconic forms necessarily activate more specific instances while arbitrary forms activate a more general and abstract representation [112].

A major challenge for current work on form to meaning correspondences in vocabulary is to link the results of behavioural studies using nonwords to patterns of systematicity, iconicity and arbitrariness in natural languages. How do different form to meaning correspondences emerge, persist or disappear in vocabularies? Here, advances in our understanding of cultural evolution can contribute crucial insights, and it is useful to briefly consider the causal processes more closely.

### *Cultural evolution and vocabulary structure*

Words are cultural items that exist by virtue of replication through social learning [113,114] and they will keep being replicated only insofar as they are learnable and meet communicative needs [115,116]. Pressures for learnability and communicative utility are bound to have an impact on the structure of language, including its patterns of arbitrariness and non-arbitrariness. Important new insights into the processes shaping vocabulary structure come from the field of cultural evolution, which studies the emergence and diffusion of cultural items and systems [117,118].

From a cultural evolutionary point of view, additions and adjustments of words in the vocabulary will be shaped by transmission biases [119] as new words are added and old ones dropped in a system that continuously passes through the bottleneck of cultural transmission [120,121]. As language learners face the task of acquiring the meanings and rules of use for thousands of vocabulary items over the years, arbitrariness, systematicity and iconicity each bring their own selective advantages and disadvantages. Over time, such advantages and disadvantages, even if they are small or limited to some sections of vocabulary, will come to shape and constrain vocabulary structure, influencing the patterning of arbitrariness, systematicity and iconicity and explaining their distribution within and across languages. One conclusion that follows from this is that a fully arbitrary vocabulary is unlikely to be a stable feature of natural languages.

Recent work in cultural evolution provides ways of empirically studying these processes. For instance, experiments in iterated learning suggest that repeated cultural transmission can turn arbitrary signals into systematic ones [122,123], showing one way in which the cues involved in systematicity may emerge. Other iterated learning experiments have shown that people can create iconic vocalizations which can be understood by naïve listeners in the same manner as people can create iconic manual gestures [124]; that the emergence of iconic signals depends on properties of meaning and modality [125,126]; and that iconic signals can be reused as discrete building blocks to form compositional (systematic) signals [127]. While interpretations of such experiments have so far focused on some measure of communicative success, they also show that the distribution of strategies for form-meaning mappings can differ across evolutionary lineages, providing a way to study the kinds of historical contingencies that have led to the differential distribution of phenomena like ideophones in today’s languages.



## Concluding remarks

We have reviewed evidence of the different relations between form and meaning found in vocabularies of the world's languages. A perfectly arbitrary language would be difficult, perhaps impossible to learn. A perfectly systematic language would not offer enough expressive freedom. A perfectly iconic language could only serve a subset of our communicative goals and may limit the power of language to abstract. As it turns out, natural languages contain a mix of all three types of form to meaning correspondences, reflecting their distinctive selective advantages in learning and communication. Processes of cultural evolution help account for the distribution of types of non-arbitrariness across the vocabulary and across languages.

We have argued that a proper understanding of the nature of form-meaning mappings in language depends on a comprehensive view of the vocabulary, of the cross-linguistic facts, and of the underlying cognitive and cultural mechanisms. Assuming arbitrariness across the board will not do; the attested form-meaning mappings in natural languages are richer than that, and our models and theories should be adjusted accordingly, with important implications for work on vocabulary structure, language processing, learning, communication and cultural evolution (see Outstanding Questions). Assuming that oft-studied Indo-European languages exemplify the most typical forms of non-arbitrariness is likewise problematic; doing so would cause us to miss out on the large ideophone systems of spoken languages and the iconic patterns of signed languages. The growing body of research reviewed here is a powerful demonstration of the importance of linguistic diversity for the cognitive sciences [13,128]. As language scientists continue to uncover the cross-linguistic dimensions of non-arbitrariness in the vocabulary, their findings will inform and constrain the kinds of mechanisms to be investigated experimentally. For instance, the iconic patterns found in ideophone systems around the world provide existence proofs of many sound-symbolic oppositions beyond *bouba-kiki*: a natural laboratory inviting further experimentation in psycholinguistics and studies of learning and communication.

The notion that the form of a word bears an essentially arbitrary relation to its meaning is changing in status from a proposed design feature into an empirical observation that accounts only partly for the attested form-meaning mappings in the world's languages. As the language sciences leave behind oversimplifying dichotomies to develop more refined models of the manifold relations between form and meaning, our understanding of language and mind will be much the richer for it.

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### Tables (3)

Table 1. Some iconic associations found in ideophones across languages [20,22]

Form	Meaning	Examples
reduplication	repetition, distribution	<i>goro</i> : <i>gorogoro</i> 'one : multiple heavy objects rolling' (Japanese) <i>wùrùfù</i> : <i>wùrùfù-wùrùfù</i> 'fluffy : fluffy here and there' (Siwu) <i>curuk-nu</i> : <i>curukcuruk-nu</i> 'a sharp prick : many sharp pricks' (Tamil) <i>kpata</i> : <i>kpata kpata</i> 'drop : scattered drops' (Ewe)
vowel quality	size, intensity	<i>katakata</i> : <i>kotokoto</i> 'clattering : clattering (less noisy)' (Japanese) <i>pimbilii</i> : <i>pumbuluu</i> 'small belly : enormous round belly' (Siwu) <i>giṅigiri</i> : <i>giṅugiru</i> 'tinkling : bell ringing' (Tamil) <i>legεε</i> : <i>logoo</i> 'slim : fat' (Ewe)
vowel lengthening	length, duration	<i>haQ</i> : <i>haaQ</i> 'short:long breath' (Japanese) <i>piQ</i> : <i>pīiQ</i> 'tear short:long strip of cloth' (Japanese) <i>dzoro</i> : <i>dzoroo</i> 'long : very long' (Siwu)
consonant voicing	mass, weight	<i>koro</i> : <i>goro</i> 'a light : heavy object rolling' (Japanese) <i>tsratsra</i> : <i>dzradzra</i> 'a light : heavy person walking fast' (Siwu) <i>kputukpluu</i> : <i>gbudugbluu</i> 'chunky : obese' (Ewe)

Table 2. Phonological cues predictive of major word classes in different languages [34]

Category	Phonological cues
English nouns	length in syllables, proportion of sounds in the word that are vowels
English verbs	approximants (e.g., l, r, w) in first syllable
Japanese nouns	fricatives (e.g., s, z), rounded vowels (e.g., o)
Japanese verbs	coronals (e.g., t, d, n)
French nouns	bilabials (e.g., p, b) in first syllable
French verbs	proportion of sounds in the word that are vowels

Table 3. Possibilities for iconicity differ by semantic domain and by modality

How easy is the iconic expression of meaning  $x$  in modality  $y$ ? This depends on the possibilities for construing structural correspondences across the two, and therefore differs by semantic domain and by modality.

Meaning	Modality	
	<i>Spoken</i>	<i>Signed</i>
Abstract concepts, logical operators, ...	hard	hard
Spatial relations, visual shape, ...	hard	easy
Sound, loudness, ...	easy	hard
Size, repetition, temporal unfolding, intensity, ...	easy	easy



**Figures (1)**

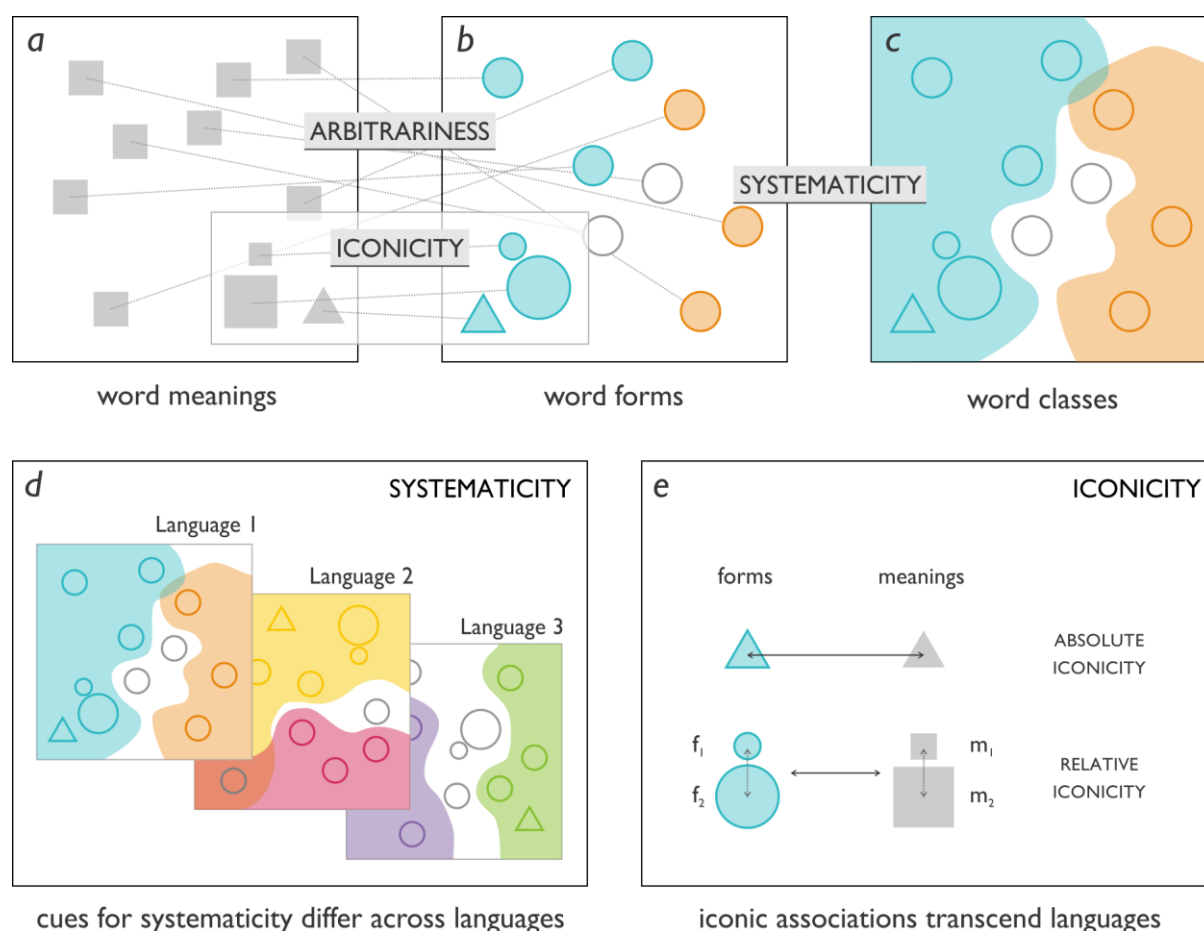


Figure 1. Arbitrariness, iconicity and systematicity

Words show **ARBITRARINESS** when there are conventional associations between word forms and meanings (a-b). Words show **ICONICITY** when there are perceptuomotor analogies between forms and meanings, here indicated by shape, size and proximity (a-b, inset). Words show **SYSTEMATICITY** when statistical regularities in phonological form, here indicated by colour, serve as cues to abstract categories like word classes; e.g., blue and orange might correspond to cues indicative of English nouns and verbs (b-c). The cues involved in systematicity differ across languages and may be arbitrary (d). The perceptual analogies involved in iconicity transcend languages and may be universal. Two non-exclusive types of iconicity are **ABSOLUTE ICONICITY**, when a form directly resembles aspects of meaning, and **RELATIVE ICONICITY**, when a contrast between forms  $\{f_1, f_2\}$  is related to an analogical contrast between meanings  $\{m_1, m_2\}$  (e).

## Boxes

### BOX 1: Forms of non-arbitrariness

**Arbitrariness** is the unpredictable mapping of form and meaning such that apart from a social convention to use word A for meaning B, there is no connection between the sound of a word and aspects of its meaning. Its converse, **non-arbitrariness**, is a relation between form and meaning such that aspects of a word's meaning or grammatical function can be predicted from aspects of its form. Non-arbitrariness may have different causes and is shaped and constrained by a range of perceptual, cognitive and communicative factors. Two important non-exclusive forms of motivation in natural language are iconicity and systematicity (Figure 1a-c).

**Iconicity** is the resemblance-based mapping between aspects of form and meaning. For instance, across spoken and signed languages, repetition in word forms is often connected to repetition in their meanings, and in ideophones in spoken languages, contrasts in vowel quality can depict analogical contrasts in magnitude [20] (Table 2). Iconicity can facilitate language learning and comprehension by providing perceptuomotor analogies between domains of experience [9]. As iconicity relies on perceptuomotor analogies, its patterns transcend languages and may be universal (Figure 1e).

**Systematicity** is the regular mapping between aspects of form and function. For instance, in many languages, major word classes can be distinguished by means of subtle differences in stress, duration, voicing, and phonotactics [34], which may be language-specific (Table 3). Given exposure to a number of words, such differences can come to serve as cues that facilitate the grouping of words into abstract categories [36]. As the cues involved in systematicity are based on phonological regularities within a given language, they are arbitrary and may be language-specific (Figure 1d).

Though these form-meaning mappings are conceptually distinct, they are not mutually exclusive in lexical items. Thus, ideophones are built from language-specific phonological inventories (introducing a degree of arbitrariness), they show various cross-linguistically recurring correspondences between form and meaning (iconicity) and they can be recognised as a word class by language-specific phonological cues (systematicity).

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### Outstanding questions

- How are types of form to meaning correspondences distributed across the languages of the world? Are certain form to meaning correspondences more likely than others to be realized in the world's languages?
  - How are types of form to meaning correspondences distributed over the different components of multi-modal signals (e.g., speech and co-speech gesture, or signs and facial expressions)?
  - How are forms of non-arbitrariness shaped and constrained by perceptual, cognitive and communicative factors? For instance, how is systematicity implemented in sign languages?
  - What are the cognitive and communicative consequences of using arbitrary versus non-arbitrary signs in a given semantic domain?
  - Is the difference between systematicity and iconicity one of kind or one of degree?
  - If non-arbitrariness is pervasive in natural languages, what are the implications for psycholinguistic models that have the assumption of arbitrariness built-in?
  - What can patterns of non-arbitrariness tell us about the evolutionary history of language and languages?
- 

### Glossary

*cultural evolution* – the evolution of cultural items (such as words and tools) according to Darwinian processes of variation, selection and social transmission

*duality of patterning* – The ability of languages to form meaningful units (morphemes, words) from non-meaningful parts (individual sounds and signs)

*ideophones* – a class of words that vividly evoke sensory impressions, e.g., sounds, movements, textures, visual patterns, actions

*iterated learning* – A type of learning in which the input to the learner was generated by previous learners and thereby constrained by what they learned

*magnitude symbolism* – iconic pairing between linguistic form and size, e.g., the use of vowel height, pitch, word length or gesture space to denote differences in the size of the referent

*morphology* – Pertaining to word structure, e.g., the use of affixes to mark tense, plurality, etc.

*onomatopoeia* – Words that imitate natural sounds, often in a highly language-specific way

*phonaesthemes* – As typically used, refer to islands of apparent non-arbitrariness, e.g., the pairing between *sn-* and having to do with noses (sneeze, sneer, snore, snot, sniff)

*phonology* – Pertaining to the systems of sounds, particularly those used contrastively, in languages

*prosody* – Pertaining to the patterns of stress and intonation in a language.

*referent* – The entity that a word or phrase stands for or denotes.

*regular sound changes* – broad changes of sounds in the vocabulary, where one sound is replaced by another in all words that contain the relevant sound.

*semiotics* – The study of signs, symbols, and how they are used.

*spatial demonstratives* – Closed-class words pertaining to spatial deixis, e.g., “this”, “that”

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