Notions of arbitrariness

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Authors are listed in order of relative contribution to the paper. LG designed the paper, wrote it and revised it, with input from all authors. All authors contributed towards conceptualization, discussion and editing. MW and HJG contributed equally to the paper.

Abstract

Arbitrariness is a distinctive feature of human language, and a growing body of comparative work is investigating its presence in animal communication. But what is arbitrariness, exactly? We propose to distinguish four notions of semiotic arbitrariness: a notion of opaque association between sign forms and semiotic functions, one of sign-function mapping optionality, one of acquisition-dependent sign-function coupling, and one of lack of motivatedness. We characterize these notions, illustrate the benefits of keeping them apart, and describe two reactions to our proposal: abandoning arbitrariness-talk in favor of the newly introduced conceptual vocabulary, or feeding the distinctions back into the parent concept.

Keywords

arbitrariness, language, animal communication, signs, functions

1. INTRODUCTION

Human language is arbitrary. Speakers of German use the word *Baum* to refer to trees, but they could have used it, and could use it, to mean something entirely different: giraffes, cookie jars, distant galaxies. Absent knowledge of its historical lineage or of the conventions that govern its use in German, a rational subject cannot infer the meaning of the term *Baum* solely by looking at its phonological envelope. Arbitrariness is a cornerstone of the spectacular richness of meanings humans can express through linguistic signs, and is widely considered to be one of the features that make language exceptional in the realm of animal communication. But what is arbitrariness, exactly?

Although the idea that human language is arbitrary is something of the proverbial platitude nobody would ever dream of denying, the concept of arbitrariness itself is elusive, often interpreted in conflicting ways and, as a result, hard to bring into focus. For a long time, the literature on arbitrariness has made three recurring claims. The first claim is that arbitrariness can be defined as the impossibility to make reliable inferences about meaning based solely on word form. Arbitrariness obtains whenever "given the sound of an unknown word, it is not possible to infer its meaning" (Monaghan et al., 2014, p. 1). The second claim is that arbitrariness is predominant in human language. Even though natural language vocabularies do feature forms of non-arbitrariness such as iconicity and systematicity,[1] they do so infrequently, whereas arbitrariness is pervasive

1. We assume that the notion of iconicity is familiar, but wish to comment briefly on systematicity. Interpreted as a term for a form of non-arbitrariness, *systematicity* does not pick out the logical interrelations among sentences and thoughts many philosophers and cognitive scientists are likely to associate with the word (Fodor & Pylyshyn, 1988). Instead, it

(Newmeyer, 1992). The third claim is that language is uniquely arbitrary. Arbitrariness is one of the "design features" that set human language apart from animal communication (Hockett, 1960).

Appealing and intuitive as these claims might sound, evidence shows that they need to be revisited. To start with, the actual use of the concept in the literature often diverges from its standard definition as the impossibility to reconstruct meaning from form. For example, Sievers & Gruber (2020) tackle the issue of the arbitrariness of primate signals, with a focus on vervet monkey alarm calls. Following Seyfarth, Cheney, & Marler (1980), they recognize that vervet calls can be characterized as "arbitrary" in the sense of lacking a correspondence between physical contour of the signal and content. But they go on to argue that the question of whether the calls of a given nonhuman primate are "arbitrary" cannot be settled so easily. The question, they suggest, should be investigated by looking at the learning and teaching processes involved in the acquisition and transmission of those calls (whether they rely on imitation learning, emulation learning, natural pedagogy), as arbitrariness "implies the possibility of a continuum of, on the one hand, fully arbitrary human words, and, at the other end, non-arbitrary, innate/hardwired signals" (Sievers & Gruber, 2020, p. 148). Clearly, speaking of arbitrariness along these lines deviates from the definition based on the dissociation between signal form and function, for the simple reason that the innateness of the tendency to produce a signal is orthogonal to whether its form licenses easy inferences about its function. Think of the American Sign Language (ASL) sign for *house* (Hochgesang, Crasborn, & Lillo-Martin, 2022). It would qualify as "non-arbitrary" relative to the criterion assessing lack of correspondence between physical contour and meaning, since it mimics the stereotypical shape of a house. But it would count as "arbitrary" relative to the transmission criterion, since it is a cultural construct acquired through social learning. This is an unwelcome predicament, for it reveals an unstable cross-disciplinary understanding of the notion, which risks leading to conceptual bubbles and hampering communication among neighboring fields.

Second, the idea that arbitrariness (classically understood as lack of correspondence between form and meaning) is all-pervasive in language is being challenged by textured views of vocabulary structure on which systematic and iconic mappings between linguistic forms and what they signify are far more widespread than previously assumed (Dingemanse et al., 2015; Dautriche et al., 2017; Winter & Perlman, 2021). One could think that because human language is a matter of convention,[2] and because being a matter of convention entails being arbitrary, human language has to be

designates the existence of statistical regularities in the mapping between sound patterns and meanings. For example, the occurrence of the consonant cluster *sl* in many words for frictionless motion, such as *slide* or *slip*. See Blasi et al. (2016).

2. As "virtually all philosophers" would agree (Rescorla, 2019).

massively arbitrary. Yet, fully conventionalized patterns of linguistic behavior can be highly non-arbitrary (Simons & Zollman, 2019; O'Connor, 2021; Gasparri, 2022), and conventions can be ranked on a scale of naturalness depending, e.g., on how much they rely on framework conditions like hardwired perceptual heuristics and cultural inheritance (Cumming, Greenberg, & Kelly, 2017). None of these developments challenges the platitude that arbitrariness is a crucial feature of human language. But they alert us to two important points. First, the mappings between word forms and meanings entrenched in natural language vocabularies may be arbitrary without *ipso facto* being haphazard or unmotivated (more on this in Section 3). Second, the orthodox assumption that arbitrariness is overwhelmingly prevalent in natural languages needs to be reassessed.

Finally, the notion that language is unique in being arbitrary collides with the considerable levels of elasticity found in the repertoires of some animal species, most notably avians and marine mammals (Lattenkamp & Vernes, 2018; Nieder & Mooney, 2020). While primate vocal repertoires are sharply fixed and resist modification through experience (Planer & Sterelny, 2021), it is well known that several birds can imitate environmental sounds and integrate song elements from neighboring species into their displays (Thompson & Boughey, 1976; Slater, 1986). Humpback whales can synchronously change their population-specific song to a new version that incorporates components from the songs of close-by populations (Noad et al., 2000; Garland et al., 2017). Assuming that the functions associated with these behaviors (mate attraction or territorial signaling) remain constant throughout recombination and change, and that the associations involved are non-iconic, the phenomenon would appear to warrant an inference that some birds and marine mammals are capable of arbitrary communication. Is that an inference one should draw, or would that be arbitrariness on the cheap?

In short, some conceptual work is needed if we want to: (a) disentangle the collection of definitions and features the notion of arbitrariness has been associated with in linguistics and animal communication research; (b) create the conditions for a refined estimate of the extent to which human language is arbitrary; and (c) facilitate comparative work on the presence of arbitrariness in nonhuman communication.

The goal of this paper is to lay the foundations of an account of arbitrariness that meets these desiderata. Section 2 makes some preliminary clarifications. Section 3 argues that to systematize the extant interpretations of the concept, we should distinguish four notions of semiotic arbitrariness: (i) a notion of opaque association between sign forms and semiotic functions; (ii) a notion of sign-function mapping optionality;[3] (iii) a notion of acquisition-dependent sign-function coupling; and

3. This component of our proposal draws on Watson et al. (2022), which suggests that the notion of *optionality* provides cross-species descriptive purchase on the evolutionary origins of the capacity to establish alternative associations

(iv) a notion of lack of motivatedness. Section 4 illustrates the benefits drawing these distinctions can bring to the research on human and nonhuman communication. Section 5 describes two possible reactions to our proposal: an eliminative one, suggesting we should abandon arbitrariness-talk in favor of the newly introduced conceptual vocabulary; and an ameliorative one, suggesting we should feed the distinctions back into the parent concept. Section 6 concludes.

2. SOME PRELIMINARIES

Before we start, we must briefly clarify two things: the wide confines of our explanandum, and what we will understand arbitrariness (however construed) to be a potential property of. These preliminaries will serve both to introduce and justify some of our terminological choices, and to allay misconceptions about what our argument seeks to shed light on.

Arbitrariness-talk spans a whooping array of domains: "arbitrary" social norms such as table manners (Gilbert, 1992); "arbitrary" reference in clauses like "let *x* be a G" (Breckenridge & Magidor, 2012); "arbitrary" judicial decisions in law (Marmor, 2009); "arbitrary" genetic codes in the life sciences (Stegmann, 2004).[4] The terms *arbitrariness* and *arbitrary* have acquired specific technical meanings in these fields, and we will not attempt to identify what, if anything, is common to their interpretation across all these areas. Instead, we shall focus on the semiotic domain (Morris, 1938). Thus, by *arbitrariness* we will mean *semiotic arbitrariness*, or arbitrariness *qua* feature of signs and semiotic transactions. We will remain neutral about the conditions for qualifying as a sign or a semiotic transaction. For example, we will not ponder whether plant volatiles or quorum sensing in bacteria are genuinely semiotic. If they are (see Ninkovic, Markovic, & Rensing (2021) on plants and Artiga (2021) on bacteria), then we intend our observations to tell us something valuable about the forms of arbitrariness one may reasonably ascribe to those systems.

Next, we will view arbitrariness as a potential property of mappings between signs and semiotic functions. For a start, we prefer to talk of *signs* over language-centric alternatives such as *expressions* or *utterances* to ensure compliance with the desiderata of cross-system and cross-species inquiry. The notion of a sign is general enough to cover natural language words, calls, gestures, group-oriented bodily displays, Morse-code-like sentences, song sequences, and so forth. We also prefer to talk of *signs* over *signals*, for two reasons. First, to isolate our argument from controversies about the necessary and sufficient conditions for something to constitute a signal (e.g.,

between signals and functions.

4. The idea of the "arbitrariness" of the mappings between the three-base triplets of mRNA and the amino acids they specify goes back to Monod (1971). It is worth recalling that Monod used the term *gratuity* (fr. *gratuité*) to label the property involved.

Wharton, 2003; Maynard-Smith & Harper, 2003; Scott-Phillips, 2008; Fröhlich & van Schaik, 2020). Second, to grant that a behavior may be semiotic, and hence qualify as a potential bearer of semiotic arbitrariness, even if it does not comply with our best criteria for signalhood. While our argument would make sense even under more stringent terminological preferences, we believe neutrality is again the better choice in this context.[5]

An analogous reasoning applies to our preference for the notion of a semiotic function over that of meaning. In linguistics and philosophy of language, *meaning* is a demanding label, whose employment is understood to be warranted on condition that, depending on one's metasemantics of choice, what it is applied to is intensional, representational, or plays a certain set of roles in the semantic component of a grammar (e.g., Riemer, 2015). Appealing to meaning in the present context would require us to antecedently settle whether nonhuman species are capable of conveying content that satisfies these constraints, which in turn would risk begging questions in favor of linguistic exceptionalism (Rendall & Owren, 2013; Scott-Philips, 2015; Townsend et al., 2017).[6] Talk of semiotic functions avoids the problem.

We also prefer *semiotic function* over *information*, which, depending on the context, appears either too narrow or too broad. It is too narrow to capture the point of semiotic behaviors which, at least *prima facie*, are not in the business of channeling information, such as animal signals directed purely at exercising social influence (Stegmann, 2013). Other contexts present the opposite problem. To illustrate, declarative uses of the sentence "Mary joined Sue" convey many pieces of information. They inform us of an event that occurred between Mary and Sue. They also tell us that *join* has a regular morphology in English. But the latter is hardly the kind of content a theorist would look at to establish whether "Mary joined Sue" is arbitrary. To bear on matters of arbitrariness, the information readable in a semiotic transaction cannot be merely conveyed by a sign. It has to be such that the sign has the semiotic function of conveying it (Lean, 2014). The

5. Note that by targeting the "arbitrary" nature of mappings between signs and semiotic functions, we are excluding from our sphere of interest the "arbitrariness" of phenomena which, though semiotic in nature, do not strictly concern the way a system maps its sign forms to their semiotic functions. An example is the combinatorial feature whereby clause embeddings in natural language can be "arbitrarily" deep (e.g., Berwick et al., 2011), which is orthogonal to the "arbitrariness" of human words.

6. To be clear, we are not implying that meaning is unique to human language. We are just noting that whether arbitrary sign-*meaning* mappings are present in nonhuman semiosis hinges on whether sign-meaning mappings are present *at all* in nonhuman semiosis. Despite evidence suggesting that some animal signals do express meanings (see Steinert-Threlkeld, Schlenker, & Chemla (2021) on referential calls in primates, and Suzuki (2016) on birds), many nonhuman signals will inevitably fall short of any reasonable standards for meaning ascriptions. Thus, *meaning* would stack the deck against the presence of arbitrariness in nonhuman communication.

sentence “Mary joined Sue” has the semiotic function of conveying a proposition about Mary’s actions, but not of telling listeners that *join* is regular, even though that is part of the information a learner can harvest from the sentence.[7]

Finally, *mapping*. By sign-function mapping, we shall mean an association between a sign and a semiotic function that is eligible for recruitment across multiple situations of use and is, or can become, part of the occasion-insensitive resources of the semiotic repertoire of a species, population, or individual. Characterizing each component of this formulation in detail would lead us too far away from our target. For present purposes, it will suffice to gloss the reference to actual and potential occasion-insensitivity. Consider sentence-level truth-conditional synonymy. A speaker of English can express the same set of truth conditions by switching between active and passive paraphrases of a base clause: “The boys admire them” and “They are admired by the boys”. It makes perfect sense to say, if only informally, that by doing so our speaker displays a capacity to “arbitrarily” select, on different occasions of use, among equally suitable candidates for an intended function. However, that does not adjudicate the arbitrariness of “The boys admire them” in the technical sense we are trying to pin down. If anything, that would be that the sentence expresses its propositional meaning without iconicity; or that nothing prevents speakers of English from revamping the norms of the language and deciding that “The boys admire them” should be understood to literally mean that elephants are heavy. The formulation we have provided emphasizes that we should be wary of assessing the “arbitrariness” of a semiotic system based on forms of occasional flexibility that are better filed under different rubrics.

3. FOUR NOTIONS OF ARBITRARINESS

With these preliminaries settled, we can turn to the matter itself. The notion of arbitrariness is interpreted in a surprisingly fragmented fashion across the spectrum of disciplines concerned with it. For instance, one would expect that linguistic work on the “arbitrariness” of human words, and comparative work on the “arbitrariness” of primate repertoires, target the presence of a unique property in their respective domains of investigation. Yet, evidence suggests otherwise. We are not alone in noting this. Planer & Kalkman (2021) have argued that despite the semblance of unity engendered by the shared appeal to the term *arbitrariness*, linguistics and animal communication research actually operate with two distinct notions of arbitrariness, which they dub *arbitrariness*$_{\mathrm{R}}$ and *arbitrariness*$_{\mathrm{A}}$. The former, dominant in linguistics, tracks the lack of resemblance between a

7. The point generalizes beyond language. For example, primate threat grunts contain cues about kinship and rank of the sender. This information can be harvested by a competent eavesdropper. But it is not part of the signaling function of the threat grunt, which is to threaten, not to inform about the sender’s identity (Planer & Sterelny, 2021, pp. 36–37).

signal and its content. The latter, dominant in work on animal communication, tracks the existence of alternative structures that might have been used in place of an actual signal.

We agree with Planer and Kalkman that the theoretical landscape features these two fundamentally distinct understandings of what it is to be "arbitrary". Yet, we believe that the dichotomy between *arbitrariness*$_{R}$ and *arbitrariness*$_{A}$ only tells us part of the story. To paint a complete picture of the ways the notion of arbitrariness has been interpreted in the literature, and to assist research on the arbitrariness of human and nonhuman communication, we believe one should do two things. First, adjust the distinction provided by Planer and Kalkman. Second, pin down two further notions, thereby obtaining *four* distinct notions of arbitrariness. Below we introduce the four notions, provide a minimal characterization of each, and conclude with a recap.[8] To motivate the taxonomy, we will draw extensively on empirical evidence from linguistics and animal communication studies. But in order to demarcate as vividly and concisely as possible the intensional and extensional differences between the four notions, we will also rely on armchair conceptual considerations and fictional examples.

Let us start with the adjustments. Planer and Kalkman's *arbitrariness*$_{R}$ centers on the lack of resemblance between signal form and content. Yet, many definitions of arbitrariness in linguistics speak of a more general feature: the impossibility to infer meaning based on sign form alone (Monaghan et al., 2014). The two properties can, and do co-occur in many prototypical examples of "non-arbitrary" words. The onomatopoeic verb *quack* resembles what it signifies (the cry of a duck), and this resemblance facilitates the formulation of hypotheses about the meaning of the verb (Imai et al., 2008; Lockwood, Dingemanse, & Hagoort, 2016).

Yet, it is a contingent partnership. Suppose Markinsese is a Martian language constructed along the lines of Wilkins's (1668) "philosophical language". Markinsese is a perfectly systematic idiom. The first character of each word signals the classification of its denotation in the largest genera of entities, and reference is narrowed by adding characters corresponding to a further subcategory of things. For instance, all names for animals in Markinsese start with <$>, all plants begin with <#>. Within plants, all terms for green algae start with <#-£>, and all terms for land plants with <#-&>. Then, all terms for land vascular plants begin with <#-&-@>, all terms for land non-vascular plants with <#-&-%>, and so forth. Suppose, further, that the Martian users of Markinsese have a hardwired knowledge of the conventions of the nomenclature, and an innate disposition to correctly

8. In saying that our characterization will be "minimal", we do not want to downplay the importance of a complete analysis of the notions involved. We just want to emphasize that since our main goal is to systematize the debate rather than to engage in heavy-duty conceptual analysis, for present purposes we shall be mainly concerned with surveying the theoretical landscape, pinpointing the four notions, and illustrating why they should be teased apart.

associate the words of Markinsese with their meanings based on the characters of the sign forms involved. In such a scenario, the Martians would be able to reliably form accurate predictions about Markinsese word meanings based solely on an observation of their graphic envelope, even when presented with unfamiliar signs. But the system would still qualify as *arbitrary*$_{R}$, since the association would not be based on resemblance.

So we need to be careful not to conflate two distinct properties of sign forms: the general property of aiding inferences about semiotic function; and the specific property of doing so by virtue of a relation of resemblance. We propose to focus on the more general property and refer to it as *opaque association between sign form and semiotic function*. This will include the absence of iconic transparency, such as the lack of resemblance between *Baum* and trees, and the absence of non-iconic means to infer semiotic function on the basis of sign form, such as the lack of statistical patterns of similarity among word forms expressing semantically close meanings (Dautriche et al., 2017). Besides serving the interest of generality, this broader category reflects the common practice of thinking of merely systematic (that is, systematic but non-iconic) associations between forms and functions as instances of "non-arbitrariness" (Perniss, Thompson, & Vigliocco, 2010; Dingemanse et al., 2016).

Next, *arbitrariness*$_{A}$. This notion is intended to capture the practice of characterizing a sign-function mapping as arbitrary depending on whether alternative sign-function mappings are possible or might have been selected in its place. The flexibility involved can manifest itself in several forms, ranging from changing the function associated with an extant sign form, to developing novel variants of a sign form while keeping its function constant, to inventing novel sign forms associated with semiotic functions previously not covered by the repertoire. We propose to classify this feature in terms of optionality (Watson et al., 2022), obtaining the notion of *sign-function mapping optionality*. Without proposing a sustained theory of what options and optionality are,[9] we suggest the following gloss: a sign-function mapping is optional if there is, or was, a real possibility that it be replaced with an alternative sign-function mapping.

The first disjunct ("if there is") characterizes forward-looking optionality: the semiotic elasticity that allows human speakers to make up a word to solve a coordination problem, or avians to associate a newly recombined song with an extant function of mate attraction. The second disjunct ("or was") adds backward-looking optionality: the feature whereby a sign-function mapping which is currently non-optional was nonetheless an open possibility within a range of alternatives at some

9. An endeavor that requires independent work on modality. See, e.g., Maier (2016; 2018) on "options" in the exercise of agentive abilities, and (Gasparri, 2021) on "real possibilities" in the dispositional realm.

earlier time.[10] To illustrate, imagine a microorganism M that has evolved to exchange information through a system of chemical signals S. Further, imagine M might have evolved to perform the same functions through an alternative, equally adaptive system S*. In this scenario, S would be optional for M in the backward-looking sense even if the repertoire is non-optional in the forward-looking one. At the center of the characterization, "real possibility" signals that ascriptions of sign-function mapping optionality are to be evaluated relative to a salient background of modally stable facts, rather than in mere counterfactual terms. Again to illustrate, imagine that in some close possible world W bonobos have a genetic, cognitive, and anatomical makeup that gives them the same semiotic elasticity as contemporary humans. For example, in W, bonobos can communicate in ASL and can easily add new conventions to their repertoire. Obviously, the conceivability of W offers no argument that actual bonobos are capable of sign-function mapping optionality. Assessments of the semiotic options "really" available to a species or individual will typically require fixing the cluster of genetic, cognitive, and anatomical features of that species or individual, while allowing for variation in external circumstances like ecological context.

We now turn to the two additional notions. We shall dub the first *acquisition-dependent sign-function coupling*. As was foreshadowed, we introduce this notion to reflect the practice of construing *arbitrary* as a technical antonym of *innate* and *hardwired* (Sievers & Gruber, 2020), as well as the widespread reference to social learning as a signature feature of arbitrariness (Nielsen & Dingemanse, 2021; Whiten, 2021). In a nutshell, a sign-function mapping involves acquisition-dependent sign-function coupling if its emergence in ontogeny is contingent on an acquisition process. To illustrate with an example from the primate domain, squirrel monkeys produce their innate vocal repertoire even if they are deaf or suffered from social isolation and parental absence (Hammerschmidt, Jürgens, & Freudenstein, 2001). By contrast, the vocalizations of marmoset monkeys are greatly affected by social isolation and lack of parental interaction (Gultekin & Hage, 2018). The vocal repertoire of squirrel monkeys follows a developmental trajectory whose deployment is not contingent on social feedback; that of marmoset monkeys involves acquisition-dependent sign-function coupling.

Notice that we are relying on a general concept of acquisition instead of the more specific concept of learning, which would render the notion too demanding and leave out some counterfactually relevant cases of non-hardwired repertoire development. Given advances in neuroscience and brain-machine interfaces, it is conceivable that someday humans will be capable of acquiring complex skills like Neo acquires Kung Fu in *The matrix*. By the same token, it is conceivable that in a hundred years or so a team of neuroscientists will invent a pill that,

10. We borrow the labels "forward-looking" and "backward-looking" from Planer & Kalkman (2021).

administered to healthy kids with degraded language capacities due to a history of social isolation, instantly makes them fluent speakers of English. There is at least an intuitive argument that neither of these two examples would qualify as a *bona fide* case of learning. However, they would fit the requirement of non-hardwired development that the present diagnostic is trying to capture.

The second additional notion surfaces in various corners of the literature, including work on syntactic iconicity, sound symbolism, language typology, and "non-functional" behavioral traditions in primates. On this notion, a sign-function mapping can be characterized as arbitrary as long as it is not *motivated* by broader structural or adaptive factors (e.g., Haiman, 1983; Givón, 2001; Klamer, 2002; Croft, 2003; Nielsen & Rendall, 2019; Nielsen & Dingemanse, 2021). In Chapter 5 of his (1916), de Saussure himself proposed to view the level of arbitrariness of a word-meaning mapping as an inverse function of how "motivated" (fr. *motivé*) the mapping is. Take numeral words. *Twenty* opaquely refers to 20, and so does *twenty-five* to 25. However, the latter is structurally less "arbitrary" than the former, since the form *twenty-five* is isomorphic to the numeral 25, and abides by the naming conventions for 5 and 20 in force in English.[11] Likewise, under the criterion of sign-function opacity, *dog* is an iconically opaque name for dogs. Yet, assuming languages are constrained by Zipfian inverse correlations between word length and familiarity (Piantadosi, 2014), it is not "arbitrary" that the name for such a commonplace referent is often monosyllabic or disyllabic (*chien* in French, *Hund* in German, *kuttā* in Hindi), as developing polysyllabic forms for terms with such a high frequency of occurrence would entail unreasonable production costs. The length of opaque and optional word forms can therefore be motivated by adaptive constraints of economy.

In the primate domain, two pertinent examples, both observed in chimpanzees, are the grass-in-ear behavior (a chimp putting a stiff blade of grass in one or both of her ears, and leaving it there for no clear reason) and the handclasp grooming posture (two partners grasping hands and raising their arms in an A-frame while grooming each other with their free hands). These behaviors are routinely classified as "arbitrary" (Bonnie et al., 2006; van Leeuwen, Cronin, & Haun, 2014). This is done in part to stress that their significance is conventionally established by the individuals in the group, and therefore that alternative patterns of behavior might have occurred in their place. But also, and crucially, to contrast their non-adaptive nature with the adaptive nature of tool use traditions, and therefore to indicate that the behavior has no observable motivation to occur.[12] Comparable appeals

11. We have adapted de Saussure's original example, which discussed *dix-neuf* and *vingt*.

12. To clarify, in the case of the handclasp posture the claim is not that grooming *per se* has no observable motivation to occur (which it has: it serves social bonding), but that grooming *in the handclasp posture* has no observable motivation to occur. Chimps could groom without raising their arms in the A-frame.

to arbitrariness-talk can be found in work on other species. For instance, Bilger et al. (2021) argue that the temporal structure of some birdsongs is not "arbitrary" since it evolved to exercise an "aesthetic impact" upon receivers. As these examples suggest, lack of motivatedness can be absolute or comparative. Accordingly, an absolutely motivated (e.g., adaptive) sign-function mapping can lack comparative motivatedness in a scenario where it is selected among a range of similarly motivated alternatives, reflecting the ordinary practice of characterizing as "arbitrary" the choices of options picked from a pool of equally or almost equally valuable alternatives (Glock, 2019; O'Connor, 2021).

To recap, we propose to distinguish the following four notions of arbitrariness.

i. A notion of *opaque association between sign forms and semiotic functions*, tracking the property defining arbitrariness in the approach dominant in linguistics. In essence, a sign-function mapping is opaque if no reliably correct prediction about sign function can be made based on sign form alone.
ii. A notion of *sign-function mapping optionality*, capturing the semiotic plasticity deemed to reveal arbitrariness in much work on nonhuman communication. As we have suggested, a sign-function mapping is optional if there is, or was, a real possibility that it be replaced by an alternative sign-function mapping.
iii. A notion of *acquisition-dependent sign-function coupling*, reflecting the practice of construing arbitrariness as an antonym of innate or hardwired repertoire development. Again in essence, acquisition-dependent sign-function coupling obtains whenever the emergence of a sign-function mapping in development is contingent on, for instance, social tutoring or exposure to teaching.
iv. A notion of *lack of motivatedness*, responding to the custom of characterizing as arbitrary the sign-function mappings that, either absolutely or comparatively, do not respond to structural pressures or do not fulfill any observable adaptive role.

Notwithstanding the preliminary nature of our characterization, it should be clear that these notions track distinct features. These features may intertwine in various ways. For instance, we mentioned that iconic associations between sign forms and functions entail some processing benefits over opaque words. Among others, they are easier to acquire for language learners (Imai et al., 2008). In cases where the entrenchment of an iconic mapping occurs due to the adaptive gains generated by these processing benefits, we face a case where the selection of sign-function transparency is motivated, and therefore a case of "iconic motivation" (Haiman, 1983).

Nonetheless, the four notions remain intensionally distinct, and the properties they track are not logically guaranteed to co-occur. For example, you might think that if a sign form can be coupled to a function only through an acquisition process, the mapping involved must be forward-looking optional. However, consider the following thought experiment. Suppose a fictional bird, the Flamatross, is neurologically and anatomically capable of developing a unique repertoire R of perfectly adaptive songs. Every member of the species invariably develops R, with no variation across generations. Flamatrosses, however, cannot acquire R unless their conspecifics teach them the system through a complex ritual that can last for months. Unless the learner is presented with the appropriate stimuli from its conspecifics, the unfortunate bird will be either able to use just a corrupted version of the repertoire, or unable to produce any signaling at all. At an earlier stage of their phylogenetic history, Flamatrosses were capable of acquiring a plurality of repertoires. Then, they converged on R. The convention became culturally stable, and members of the species systematically transmitted R through social learning. Over time, due to sustained cultural stability, the capacity to produce alternative repertoires was lost, but the species never evolved a capacity to develop R in the absence of teaching, since social learning persisted as an accessible resource in its natural environment. Flamatrosses seem readily conceivable. Hence, acquisition-dependent sign-function coupling does not entail forward-looking mapping optionality.

In Section 4 we will say more about how drawing these distinctions, in addition to producing an orderly classification of the ways in which the concept of arbitrariness has *de facto* been interpreted in the literature, generates descriptive benefits. Before continuing, we must, however, consider an objection. We started by observing that the diagnostics for arbitrariness populating the literature track distinct properties, and took this to justify an inference that theorists must be operating with distinct concepts of arbitrariness. Were we going too fast? Maybe we are not dealing with distinct *concepts* of arbitrariness, but just with different *conceptions* of it, that is, ways of thinking about a unique concept from different vantage points, and of addressing the epistemic bottlenecks that those vantage points entail.[13] Perhaps what the emphasis on learning in studies like Sievers & Gruber (2020) indicates, is not that they are understanding arbitrariness to consist of something distinct from what linguists have in mind (form-function opaqueness), but that in addressing primate repertoires one cannot take for granted many of the distinctive features of "arbitrary" communication that are manifest in human language, such as its dependence on social learning. So

13. See Higginbotham (1986) for a linguistically minded classic on conceptions, and Sawyer (2021) for a recent contribution on the topic in philosophy of mind. Note that the objection would not take off under a psychologistic view on which concepts reduce to conceptions. The objection rests on the orthodox position that concepts are public representational devices individuals can conceive of in different ways.

it makes sense to provisionally adopt a conception of arbitrariness centered on the manner of sign-function coupling in development. Subscribing to different discipline-specific conceptions of a concept does not entail the individuation of a pool of discipline-specific concepts. Thus, the inference of distinct notions of arbitrariness is not a safe one to draw in the present context.

In reply, we believe this diagnosis would be too optimistic. Minimally, for two conceptions C_1 and C_2 to be conceptions of a unique concept K (e.g., *the* concept of arbitrariness), C_1 and C_2 must not entail inconsistent intensions for K. For example, two subjects may have different conceptions of the concept of an elk and associate it with different stereotypical traits while being in an underlying agreement about how one should go about determining whether an individual is an elk. Our two subjects cannot, however, merely bear diverging conceptions of the concept of an elk if, say, they subscribe to substantially different theories of the necessary conditions for something to qualify as an elk. If they do, they must be operating with distinct concepts of an elk. In the case of arbitrariness, the mosaic of interpretations we have surveyed seems to feature the latter form of disagreement. First, the interpretations warrant substantially different extensional verdicts about whether a sign-function mapping should be characterized as "arbitrary". Second, their substitution generates inconsistent intensional results. For instance, talk of a continuum between "innate" and "fully arbitrary" signals makes perfect sense if we tie the label *arbitrary* to the diagnostic centered on mode of sign-function coupling, but not if we switch to sign-function transparency. The very idea of distributing repertoires on a spectrum ranging between the fully innate and the fully opaque is incoherent. The two features can co-occur, and *do* co-occur in central explananda like primate calls. So the diversity of takes in play cannot be reduced to the proliferation of divergent conceptions of a unique concept under the pressure of discipline-specific epistemic constraints. We truly face an array of distinct concepts.

4. GETTING THINGS INTO FOCUS

We now turn to the descriptive benefits of distinguishing the four notions. We were looking for an analysis capable of: (a) systematizing the complex array of traits the notion of arbitrariness has been associated with in linguistics and animal communication research; (b) aiding a refined estimate of the extent to which human language can be characterized as "arbitrary"; (c) sustaining comparative work on the potential presence of "arbitrary" semiosis outside the human realm. We believe there are improvements on each of these counts.

As for (a), the distinctions disentangle the conflicting construals of arbitrariness populating the literature and assign each of them a dedicated label, which curtails the risk of confusion and talking at cross purposes. Each notion can lay claim to providing a categorization policy that theorists

should consider in evaluating the arbitrariness of a semiotic repertoire. But from the vantage point of the newly introduced conceptual landscape, *sic-et-simpliciter* questions about whether or not a sign-function mapping is "arbitrary" are no longer antecedently tractable. They become tractable as soon as they are precisified and one states which specific diagnostic, or combination thereof, the label should be understood to track. One example we have considered is the ASL sign for *house*, which qualifies as "non-arbitrary" if the adjective is understood to probe for iconic opaqueness, and as "arbitrary" if the adjective denotes being a non-hardwired construct acquired via social learning. The distinctions dispel the confusion. The ASL sign for *house* is optionally mapped to its function (signers could refer to houses through another configuration), it instantiates a significant degree of form-function transparency (it is iconic), it is acquisition-dependent (it is learned), and so forth.

As for (b), the four notions increase the level of precision and granularity at which we can formulate the questions previously gathered under the loose rubric of the "arbitrariness of language". We can disentangle the optionality and the learning-dependence of human words from the extent to which natural language vocabularies rely on transparent associations between word forms and semantic functions. We can further distinguish, among those, the non-opaque associations that facilitate predictions about function based on resemblance, from those that do so by virtue of resemblance-insensitive regularities. Examples of the former variety of transparency are given by the way the prosodic and segmental characteristics of ideophones aid inferences about meaning (e.g., *zigzag* as an onomatopoeic verb for movement along a series of sharp turns), by the isomorphism between mouth configurations and external shapes triggering the *kiki/bouba* effect (Kovic, Plunkett, & Westermann, 2010), and by the relationship between visual forms and inferences about verb telicity in sign language (Strickland et al., 2015). An example of the latter variety of transparency would be the systematic regularity whereby words featuring a consonant cluster opaquely associated with a conceptual domain (e.g., the non-iconic relationship between *gl* and light or vision) will tend to denote objects and properties in that domain (*glister*, *glow*, *glare*) (Blasi et al., 2016). We can ask how prevalent these varieties of transparency are in language, and whether the frequency at which they occur in human vocabularies constitutes an *unicum* in the realm of animal communication.

Continuing further, humans are capable of remarkable levels of sign-function mapping optionality, as well as of establishing unmotivated sign-function mappings. For example, without any particular reason for doing so, we could decide to coin a new word, *Lisburgh*, and give it a disjunctive character that makes it refer to Lisbon if it rains, and to Edinburgh whenever the skies are clear above us. In sum, it is clear that the properties tracked by the four notions will be instantiated to a significant degree by human languages. But these degrees may vary. Armed with

the distinctions we have proposed, the theorist can look into each of the corresponding properties, and assess its presence in human communication with the aid of a specialized conceptual toolbox.

As for (c), none of the notions we have individuated is language-centric, or carries lateral commitments that would hinder their application outside the confines of linguistics. Thus, they are all set for comparative research. For example, the notion of acquisition-dependent sign-function coupling is not especially suited to human language. It allows the theorist to capture the contrast between nonhuman species in which repertoire development is contingent on social learning, and those in which a non-degraded repertoire can be developed even in its absence. The same goes for the capacity to establish opaque sign-function mappings, which is taxonomically frequent in the nonhuman realm. For example, to qualify as iconically opaque, it suffices that a signal type displays a significant lack of correspondence between observable physical contour and function, a feature which is widely distributed across primate vocalizations and other animal species.

Similar observations extend to motivatedness and sign-function mapping optionality, none of which presupposes anything specific to linguistic communication. For instance, should bacterial signaling turn out to warrant a genuine characterization in semiotic terms (Artiga, 2021), the notion of sign-function mapping optionality could be used to inquire into the phylogenetic and ontogenetic possibility of alternative communication technologies in bacteria. Like the other two notions, motivatedness and sign-function mapping optionality are also portable, meaning that they can be extended outside the semiotic realm by relaxing the constraints on their relata. Again as an example, extant analyses of the "arbitrariness" of the genetic code are cashed out in modal terms and attached to the possibility of alternatives (Stegmann, 2004; Lean, 2019). We could characterize the phenomenon as an instance of backward-looking mapping optionality between non-semiotic units and chemical functions. Further, we could inquire into whether the actual genetic code, while adaptive and therefore absolutely motivated, might have been replaced by an equally adaptive alternative, which would make the actual code comparatively unmotivated, and hence "arbitrary" in terms of relative adaptive value.

5. REPLACEMENT OR AMELIORATION?

Metatheoretical work on conceptual engineering (e.g., Cappelen, 2018; Burgess, Cappelen, & Plunkett, 2020) distinguishes three basic kinds of conceptual intervention: interventions to *introduce* a new concept or term; interventions to *abandon* a certain concept or term; and interventions to *revise* a certain concept or term. In Sections 3 and 4, we decomposed the concept of arbitrariness into four more specific notions, and made our case for the benefits of doing so. In this section, we reflect on whether the *introduction* of the four notions should terminate in the

abandonment or in the *revision* of the parent concept of arbitrariness. For brevity, we call these reactions Replacement and Amelioration. On Replacement, we should combine the introduction of the four notions with a verdict of abandonment. On Amelioration, we should engineer an improved concept of arbitrariness that assimilates the distinctions we have drawn. Our aim here is not to argue conclusively in favor of either reaction, nor is it to argue that they are the only possible reactions in logical space. We will simply pin down the immediate attractions and downsides of each so that further discussion on their merits can take place.[14]

Let us start with Replacement: The newly introduced notions should replace the parent concept of arbitrariness. The controversies surrounding its interpretation suggest that no single concept will ever be able to play the grab bag of roles the notion of arbitrariness has been tasked with playing in the literature. Thus, we should replace it with the particularized conceptual vocabulary we have provided. One option would be to preserve the term *arbitrariness* as a label for the opaque association between sign forms and semiotic functions (after all, this is the dominant interpretation of the term in linguistics), and adopt dedicated names for the remaining three notions. Another option would be to stop relying on arbitrariness-talk altogether, because even if we are careful to state the due precisifications, the circuitous history of the label might stir up latent preconceptions and reinstate conceptual mix-ups. We should obliterate the terms *arbitrary* and *arbitrariness* from our theoretical toolkit, and just ask whether sign forms are opaquely associated with their semiotic functions, whether a species is capable of sign-function mapping optionality, whether a sign-function coupling is acquisition-dependent, and whether a sign-function mapping is motivated. Replacement would be terminologically revisionary but would maximize epistemic security, since it would involve accepting the introduction of the specialized notions without drawing further hypotheses about the way they might be recombined.

Amelioration would involve the complementary approach: We should find a way to feed the distinctions back into the parent concept. As much as there are arguments for an eliminative reaction, splintering the terminological playing field would alleviate the incongruities that motivated the four specific notions while renouncing conceptual unification. We would relinquish a general notion of arbitrariness that different fields can converge on and share in cross-disciplinary research endeavors, together with the idea that the research on semiotic arbitrariness, however in need of reform, concerns a unified subject matter. That would be, one might argue, a lazy man's approach to conceptual proliferation. *Ceteris paribus*, it would be preferable to preserve

14. In addition to work on conceptual engineering, our reasoning below is indebted to work on conservatism and speculation in science, and especially to Currie (2021).

terminological continuity and engineer a revised-and-improved notion of arbitrariness adjusted to the conceptual complexity we have surveyed.

The move could be implemented in a variety of ways, but here is one. We introduce an ameliorated notion of arbitrariness^{+} (labeled with a provisional "+" to mark that we are speaking of the ameliorated notion) ranging between two theoretical extremes: null arbitrariness^{+} and full-blooded arbitrariness^{+}, with various degrees in between. Next, we define the theoretical extremes as follows. A sign-function mapping, or repertoire thereof, is perfectly arbitrary^{+} if and only if it satisfies to the highest degree the conjunction of the four diagnostics, and perfectly non-arbitrary^{+} if it does not satisfy any of the four diagnostics to any degree. Accordingly, full-blooded arbitrariness^{+} obtains whenever a sign-function mapping is perfectly opaque, optional, acquisition-dependent, and unmotivated; vice versa for non-arbitrariness^{+}. Real-world examples from human and nonhuman communication will occupy a position on the continuum between these two theoretical extremes. Amelioration would be terminologically conservative but epistemically speculative, since it would involve drawing a further hypothesis about the way the notions we have distinguished might be recombined.

Which of these solutions should we go for? Suppose you have sympathies toward Replacement. After all, realizing that a familiar concept needs to be split up in a plurality of finer-grained notions, is progress. Thus, we should be happy to get rid of arbitrariness-talk and replace it with the battery of notions we have reviewed, since the maneuver enhances the specialization and rigor of our conceptual apparatus. Furthermore, Amelioration seems to entail the possibility of ascribing matching levels of arbitrariness^{+} under varying combinations of the four specific features. Two mappings may occupy the same position on the conjunctive spectrum of arbitrariness^{+} while exhibiting distinct underlying levels of opaqueness, optionality, acquisition dependency, and lack of motivatedness. Instead of aiding theory production, this might obstruct the appreciation of important differences among the mappings involved. Finally, it is hard to predict whether cross-disciplinary work would benefit from keeping a revised notion of arbitrariness in the game. Suppose empirical evidence reveals that there are robust patterns of co-occurrence among the four features, and that interesting degrees of any of them in a semiotic system systematically raise the probability that interesting degrees of the other features will also be found in that system. One could think that the existence of statistical patterns of this sort would speak in favor of Amelioration. But the matter appears more complex. Even if the features did tend to cluster, the fragmentation of interpretations we diagnosed on the way to identifying the four notions may undercut the statistical argument. Terminological conservatism could hamper the cause of conceptual improvement. For example, by sheer force of associative habit, preserving arbitrariness-talk could foment the tendency to revert to

the pre-amelioration scenario, and therefore leave the fragmentation unaffected. Or it could lead to a situation where business-as-usual and ameliorated construals of the label are pursued in parallel by different groups of theorists, and therefore aggravate the fragmentation instead of alleviating it.

Yet, these reservations may be too cautious. The productivity of proposals like Amelioration is to be judged relative to the theoretical situation they address, and the epistemic advantages they seek to generate. In the present case, both variables suggest that the strategy deserves consideration. Besides addressing the fragmentation that led us to distinguish the four notions, Amelioration would vindicate the intuition that the various facets of the research on arbitrariness concern a common subject matter approached from different angles. It would also allow the parties to the fragmentation to converge on a shared protocol for arbitrariness-talk that does not require drastic terminological cuts. Amelioration pays heed to the historical importance of the label in the language sciences, and does not ask those working on the "arbitrariness" of, say, primate vocalizations to dispose of the term *arbitrariness*. It just invites them to tailor their employment of the label to the criteria for arbitrariness^{+} in the interest of making sure that every player in the cross-disciplinary spectrum abides by the same conceptual rules. A regimen that produces a single notion of arbitrariness that incorporates the diverse ways in which the concept has been interpreted, and that establishes an application policy which can be cohesively employed across domains of inquiry, is preferable to (and might be easier to implement in practice than) one that lacks any of these two features.

As for the problems raised by the possibility of ascribing matching levels of arbitrariness^{+} under variable combinations of the specialized criteria, and by the co-existence of business-as-usual and ameliorated takes on the concept, they do not look intractable. The co-existence issue is a common concern for ameliorative interventions and hardly constitutes a principled reason against engaging in them (Sterken, 2020). The matching issue can be met by introducing the relevant disambiguations whenever necessary, possibly through appropriate representational aids. For instance, one could represent the arbitrariness^{+} of a sign-function mapping, or of a whole semiotic system, through a multi-factor scoring system akin to the one used by Godfrey-Smith (2009, pp. 63–67) for Darwinian populations, which projects on a three-dimensional plane the degrees to which populations exhibit fidelity of heredity, continuity of fitness landscape, and dependence of reproductive differences on intrinsic character. In the present case, since we are dealing with four logically independent variables, the job could be done through a radar chart with four axes, one for each of the features in play.[15] Finally, ameliorative moves of this kind are not unheard of in the comparative literature. For example, Schel et al. (2013) have made a structurally analogous proposal about intentionality. They identify three distinct criteria previously described as warranting

15. See Watson et. al. (2022) for an application specific to optionality.

an inference that a primate gesture is intentional: social directedness, goal-directedness, and association with visual monitoring of the audience. Next, they establish that a signal is intentional if and only if it satisfies the conjunction of the three criteria. And conclude that alarm calls are intentional in chimpanzees, as they satisfy all three criteria.

As we made clear, our purpose in this section was not to champion any conclusive verdict on whether one should prefer a reaction like Amelioration or Replacement. As best we can tell, the competition between the two strategies is open, and making a definitive recommendation would require a cost-benefit analysis that we cannot provide here. In any case, if you accept our line of argument, you should also accept that it takes us to a theoretical choice point that calls for a decision on our part.

6. CONCLUSION

We have proceeded as follows. Section 1 introduced the concept of semiotic arbitrariness and explained why it calls for elucidation. Section 2 provided some preliminary clarifications. Section 3 argued that to systematize the diverging interpretations of the concept, one should distinguish four notions of semiotic arbitrariness: (i) a notion of opaque association between sign forms and semiotic functions; (ii) a notion of sign-function mapping optionality; (iii) a notion of acquisition-dependent sign-function coupling; and (iv) a notion of lack of motivatedness. Section 4 exemplified the benefits drawing these distinctions can bring to the research on human and nonhuman communication. Section 5 concluded by describing an eliminative and an ameliorative reaction to our proposal. The job is not finished, but we hope our discussion will help steer the cross-disciplinary work on arbitrariness away from conceptual and terminological quicksands.

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REFERENCES

Artiga, M. (2021). Bacterial communication. *Biology & Philosophy*, *36*(4), 39.

Berwick, R. C., Okanoya, K., Beckers, G. J. L., & Bolhuis, J. J. (2011). Songs to syntax: the linguistics of birdsong. *Trends in Cognitive Sciences*, 15(3), 113–121.

Bilger, H. T., Vertosick, E., Vickers, A., Kaczmarek, K., & Prum, R. O. (2021). Higher-order musical temporal structure in bird song. *Frontiers in Psychology*, *12*, 629456.

Blasi, D. E., Wichmann, S., Hammarström, H., Stadler, P. F., & Christiansen, M. H. (2016). Sound-meaning association biases evidenced across thousands of languages. *Proceedings of the National Academy of Sciences*, *113*(39), 10818–10823.

Bonnie, K. E., Horner, V., Whiten, A., & de Waal, F. B. M. (2007). Spread of arbitrary conventions among chimpanzees: A controlled experiment. *Proceedings of the Royal Society B: Biological Sciences*, *274*(1608), 367–372.

Burgess, A., Cappelen, H., & Plunkett, D. (Eds.). (2020). *Conceptual Engineering and Conceptual Ethics*. Oxford: Oxford University Press.

Breckenridge, W., & Magidor, O. (2012). Arbitrary reference. *Philosophical Studies*, *158*(3), 377–400.

Cappelen, H. (2018). *Fixing Language: An Essay on Conceptual Engineering*. Oxford: Oxford University Press.

Cumming, S., Greenberg, G., & Kelly, R. (2017). Conventions of viewpoint coherence in film. *Philosophers' Imprint*, *17*(1), 1–28.

Croft, W. (2003). *Typology and Universals*. 2nd edn. Cambridge: Cambridge University Press.

Currie, A. (2021). Science and speculation. *Erkenntnis*. https://doi.org/10.1007/s10670-020-00370-w

Dautriche, I., Mahowald, K., Gibson, E., & Piantadosi, S. T. (2017). Wordform similarity increases with semantic similarity: an analysis of 100 languages. *Cognitive Science*, *41*(8), 2149–2169.

de Saussure, F. (1916). *Cours de Linguistique Générale*. Lausanne-Paris: Payot.

Dingemanse, M., Blasi, D. E., Lupyan, G., Christiansen, M. H., & Monaghan, P. (2015). Arbitrariness, iconicity, and systematicity in language. *Trends in Cognitive Sciences*, *19*(10), 603–615.

Dingemanse, M., Schuerman, W., Reinisch, E., Tufvesson, S., & Mitterer, H. (2016). What sound symbolism can and cannot do: Testing the iconicity of ideophones from five languages. *Language*, *92*(2), e117–e133.

Fodor, J. A., & Pylyshyn, Z. W. (1988). Connectionism and cognitive architecture: A critical analysis. *Cognition*, *28*(1–2), 3–71.

Fröhlich, M., & van Schaik, C. P. (2020). Must all signals be evolved? A proposal for a new classification of communicative acts. *WIREs Cognitive Science*, *11*(4), e1527.

Garland, E. C., Rendell, L., Lamoni, L., Poole, M. M., & Noad, M. J. (2017). Song hybridization events during revolutionary song change provide insights into cultural transmission in humpback whales. *Proceedings of the National Academy of Sciences*, *114*(30), 7822–7829.

Gasparri, L. (2021). Proportional dispositional predicates. *Synthese*, *199*(5–6), 12363–12383.

Gasparri, L. (2022). Lexical innovation and the periphery of language. *Linguistics and Philosophy*, *45*(1), 39–63.

Gilbert, M. (1992). *On Social Facts*. Princeton, NJ: Princeton University Press.

Givón, T. (2001). *Syntax: An Introduction*. Amsterdam: Benjamins.

Glock, H.-J. (2019). The normativity of meaning revisited. In Roughley, N., & Bayertz, K., (Eds.), *The Normative Animal? On the Anthropological Significance of Social, Moral, and Linguistic Norms* (pp. 295–318). Oxford: Oxford University Press.

Godfrey-Smith, P. (2009). *Darwinian Populations and Natural Selection*. New York, NY: Oxford University Press.

Gultekin, Y. B., & Hage, S. R. (2018). Limiting parental interaction during vocal development affects acoustic call structure in marmoset monkeys. *Science Advances*, *4*(4), eaar4012.

Haiman, J. (1983). Iconic and economic motivation. *Language*, *59*(4), 781–819.

Hammerschmidt, K., Jürgens, U., & Freudenstein, T. (2001). Vocal development in squirrel monkeys. *Behaviour*, *138*(9), 1179–1204.

Higginbotham, J. (1998). Conceptual competence. *Philosophical Issues*, *9*, 149–162.

Hochgesang, J. A., Crasborn, O., & Lillo-Martin, D. (2022). ASL sign for "house". *ASL Signbank*. New Haven, CT: Haskins Lab, Yale University. Retrieved in January 2022. https://aslsignbank.haskins.yale.edu/dictionary/gloss/486.html

Hockett, C. F. (1960). The origin of speech. *Scientific American*, *203*(3), 88–96.

Imai, M., Kita, S., Nagumo, M., & Okada, H. (2008). Sound symbolism facilitates early verb learning. *Cognition*, *109*(1), 54–65.

Klamer, M. (2002). Semantically motivated lexical patterns: a study of Dutch and Kambera expressives. *Language*, *78*(2), 258–286.

Kovic, V., Plunkett, K., & Westermann, G. (2010). The shape of words in the brain. *Cognition*, *114*(1), 19–28.

Lattenkamp, E. Z., & Vernes, S. C. (2018). Vocal learning: A language-relevant trait in need of a broad cross-species approach. *Current Opinion in Behavioral Sciences*, *21*, 209–215.

Lean, O. M. (2014). Getting the most out of Shannon information. *Biology & Philosophy*, *29*(3), 395–413.

Lean, O. M. (2019). Chemical arbitrariness and the causal role of molecular adapters. *Studies in History and Philosophy of Science Part C*, *78*, 101180.

Lockwood, G., Dingemanse, M., & Hagoort, P. (2016). Sound-symbolism boosts novel word learning. J*ournal of Experimental Psychology: Learning, Memory, and Cognition*, *42*(8), 1274–1281.

Maier, J. (2016). Modal predicates. *Linguistics and Philosophy*, *39*(6), 443–457.

Maier, J. (2018). Ability, modality, and genericity. *Philosophical Studies*, *175*(2), 411–428.

Marmor, A. (2009). *Social Conventions: From Language to Law*. Princeton, NJ: Princeton University Press.

Maynard-Smith, J., & Harper, D. (2003). *Animal Signals*. New York, NY: Oxford University Press.

Monaghan, P., Shillcock, R. C., Christiansen, M. H., & Kirby, S. (2014). How arbitrary is language? *Philosophical Transactions of the Royal Society B*, *369*(1651), 20130299.

Monod, J. (1971). *Chance and Necessity*. New York, NY: Alfred A. Knopf.

Morris, C. W. (1938). *Foundations of the Theory of Signs*. Chicago, IL: The University of Chicago Press.

Newmeyer, F. J. (1992). Iconicity and generative grammar. *Language*, *68*(4), 756–796.

Nieder, A., & Mooney, R. (2020). The neurobiology of innate, volitional and learned vocalizations in mammals and birds. *Philosophical Transactions of the Royal Society B*, *375*(1789), 20190054.

Nielsen, A. K. S., & Dingemanse, M. (2021). Iconicity in word learning and beyond: A critical review. *Language and Speech*, *64*(1), 52–72.

Nielsen, A. K. S., & Rendall, D. (2019). Comparative perspectives on communication in human and nonhuman primates. In Frühholz, S., & Belin, P., (Eds.), *The Oxford Handbook of Voice Perception* (pp. 278–308). Oxford: Oxford University Press.

Ninkovic, V., Markovic, D., & Rensing, M. (2021). Plant volatiles as cues and signals in plant communication. *Plant, Cell & Environment*, *44*(4), 1030–1043.

Noad, M. J., Cato, D. H., Bryden, M. M., Jenner, M.-N., & Jenner, K. C. S. (2000). Cultural revolution in whale songs. *Nature*, *408*(6812), 537–537.

O'Connor, C. (2021). Measuring conventionality. *Australasian Journal of Philosophy*, *99*(3), 579–596.

Perniss, P., Thompson, R. L., & Vigliocco, G. (2010). Iconicity as a general property of language: Evidence from spoken and signed languages. *Frontiers in Psychology*, *1*. https://doi.org/10.3389/fpsyg.2010.00227

Piantadosi, S. T. (2014). Zipf's word frequency law in natural language: A critical review and future directions. *Psychonomic Bulletin & Review*, *21*(5), 1112–1130.

Planer, R. J., & Kalkman, D. (2021). Arbitrary signals and cognitive complexity. *The British Journal for the Philosophy of Science*, *72*(2), 563–586.

Planer, R. J., & Sterelny, K. (2021). *From Signal to Symbol: The Evolution of Language*. Cambridge, MA: MIT Press.

Rendall, D., & Owren, M. J. (2013). Communication without meaning or information: Abandoning language-based and informational constructs in animal communication theory. In U. E. Stegmann, (Ed.), *Animal Communication Theory* (pp. 151–188). Cambridge: Cambridge University Press.

Rescorla, M. (2019). Convention. In E. N. Zalta, (Ed.), *The Stanford Encyclopedia of Philosophy (Summer 2019 Edition)*. https://plato.stanford.edu/archives/sum2019/entries/convention/

Riemer, N. (Ed.). (2015). *The Routledge Handbook of Semantics*. London: Routledge.

Sawyer, S. (2021). Concepts, conceptions and self-knowledge. *Erkenntnis*, *86*(1), 237–254.

Schel, A. M., Townsend, S. W., Machanda, Z., Zuberbühler, K., & Slocombe, K. E. (2013). Chimpanzee alarm call production meets key criteria for intentionality. *PLoS ONE*, *8*(10), e76674.

Scott-Phillips, T. C. (2008). Defining biological communication. *Journal of Evolutionary Biology*, *21*(2), 387–395.

Scott-Phillips, T. C. (2015). Meaning in animal and human communication. *Animal Cognition*, *18*(3), 801–805.

Seyfarth, R. M., Cheney, D. L., & Marler, P. (1980). Vervet monkey alarm calls: Semantic communication in a free-ranging primate. *Animal Behaviour*, *28*(4), 1070–1094.

Sievers, C., & Gruber, T. (2020). Can nonhuman primate signals be arbitrarily meaningful like human words? An affective approach. *Animal Behavior and Cognition*, *7*(2), 140–150.

Simons, M., & Zollman, K. J. S. (2019). Natural conventions and indirect speech acts. *Philosophers' Imprint*, *19*(9), 1–26.

Slater, P. J. B. (1986). The cultural transmission of bird song. *Trends in Ecology & Evolution*, 1, 94–97.

Stegmann, U. E. (2004). The arbitrariness of the genetic code. *Biology & Philosophy*, *19*(2), 205–222.

Stegmann, U. E., (Ed.). (2013). *Animal Communication Theory: Information and Influence*. Cambridge: Cambridge University Press.

Steinert-Threlkeld, S., Schlenker, P., & Chemla, E. (2021). Referential and general calls in primate semantics. *Linguistics and Philosophy*, *44*(6), 1317–1342.

Sterken, R. K. (2020). Linguistic intervention and transformative communicative disruptions. In Burgess, A., Cappelen, H., Plunkett, D., (Eds.), *Conceptual Engineering and Conceptual Ethics* (pp. 417–434). Oxford: Oxford University Press.

Strickland, B., Geraci, C., Chemla, E., Schlenker, P., Kelepir, M., & Pfau, R. (2015). Event representations constrain the structure of language: Sign language as a window into universally accessible linguistic biases. *Proceedings of the National Academy of Sciences*, *112*(19), 5968–5973.

Suzuki, T. N. (2016). Semantic communication in birds: Evidence from field research over the past two decades. *Ecological Research*, *31*(3), 307–319.

Thompson, N. S., & Boughey, M. J. (1976). Species specificity and individual variation in the songs of the Brown Thrasher (*Toxostoma Rufum*) and Catbird (*Dumetella Carolinensis*). *Behaviour*, *57*(1–2), 64–89.

Townsend, S. W., Koski, S. E., Byrne, R. W., Slocombe, K. E., Bickel, B., Boeckle, M., … Manser, M. B. (2017). Exorcising Grice's ghost: An empirical approach to studying intentional communication in animals: Intentional communication in animals. *Biological Reviews*, *92*(3), 1427–1433.

van Leeuwen, E. J. C., Cronin, K. A., & Haun, D. B. M. (2014). A group-specific arbitrary tradition in chimpanzees (*Pan troglodytes*). *Animal Cognition*, *17*(6), 1421–1425.

Watson, S. K., Filippi, P., Gasparri, L., Falk, N. G., Tamer, N., Widmer, P., Manser, M., & Glock, H.-J. (2022). Optionality in animal communication: A novel framework for examining the evolution of arbitrariness. *Biological Reviews*. https://doi.org/10.1111/brv.12882

Wharton, T. (2003). Natural pragmatics and natural codes. *Mind & Language*, *18*(5), 447–477.

Whiten, A. (2021). The burgeoning reach of animal culture. *Science*, *372*(6537), eabe6514.

Wilkins, J. (1668). *An Essay Towards a Real Character and a Philosophical Language*. London: Gellibrand.

Winter, B., & Perlman, M. (2021). Size sound symbolism in the English lexicon. *Glossa: A Journal of General Linguistics*, *6*(1), 79.