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BRIEF REPORT

# What Is Simple Is Actually Quite Complex: A Critical Note on Terminology in the Domain of Language and Communication

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On the surface, the fields of animal communication and human linguistics have arrived at conflicting theories and conclusions with respect to the effect of social complexity on communicative complexity. For example, an increase in group size is argued to have opposite consequences on human versus animal communication systems: although an increase in human community size leads to some types of language simplification, an increase in animal group size leads to an increase in signal complexity. But do human and animal communication systems really show such a fundamental discrepancy? Our key message is that the tension between these two adjacent fields is the result of (a) a focus on different levels of analysis (namely, signal variation or grammar-like rules) and (b) an inconsistent use of terminology (namely, the terms "simple" and "complex"). By disentangling and clarifying these terms with respect to different measures of communicative complexity, we show that although animal and human communication systems indeed show some contradictory effects with respect to signal variability, they actually display essentially the same patterns with respect to grammar-like structure. This is despite the fact that the definitions of complexity and simplicity are actually aligned for signal variability, but diverge for grammatical structure. We conclude by advocating for the use of more objective and descriptive terms instead of terms such as "complexity," which can be applied uniformly for human and animal communication systems—leading to comparable descriptions of findings across species and promoting a more productive dialogue between fields.

*Keywords:* animal communication, language, complexity, variability, group size

Terminological misalignments constitute one of the main challenges for interdisciplinary research. At times, the very same term can be used in very different ways across related fields, hampering disciplinary integration and cross-disciplinary synthesis. This is especially the case for comparative cognition. In this article, we focus on the use of the terms "simple" and "complex" in the related fields of animal communication and linguistics, and ask whether claims made using these terms across disciplines can be aligned once they are juxtaposed.

One particularly salient illustration of the issue which is at the heart of this article, is provided by the influential "social complexity hypothesis for communicative complexity" (Blumstein & Armitage, 1997; Darwin, 1872; de Lamarck, 1809; Freeberg et al., 2012; Peckre et al., 2019; Roberts & Roberts, 2019; Whiten & Byrne, 1988). This hypothesis is generally captured by statements such as the following: "*groups with complex social systems require more complex communicative systems to regulate interactions and relations among group members*" (Freeberg et al., 2012). Complex social systems can stem from differences in group size, network connectedness, egalitarianism, diversity of roles, density, and more. Specifically, with respect to group size, the social complexity hypothesis predicts that animal individuals living in bigger groups would display greater communicative complexity compared to those living in smaller groups. On the face of

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it, the exact opposite conclusion is drawn in the field of language sciences, where the focus is squarely on human languages. According to the popular "linguistic niche hypothesis," individuals living in bigger communities would have less complex languages compared to small communities (Lupyan & Dale, 2010; Meir et al., 2012; Wray & Grace, 2007), as they usually share less common ground and have less frequent interactions with each other, which leads to a stronger pressure in favor of more regular and predictable languages that can in turn ease communication between strangers (Raviv et al., 2019). This prediction is captured by quotes such as "*languages with greater populations are more likely to use a less morphologically complex strategy*" (Lupyan & Dale, 2010) and "*languages spoken in larger communities tend to be less complex*" (Raviv et al., 2019). Putting passages from these two fields side by side creates the impression of an interdisciplinary conflict and clashing conclusions, in which an increase in social complexity (as reflected, for instance, in an increase in community size) affects communicative complexity in a different way depending                                                              on species—human languages simplify, whereas animal communication systems become more complex (Figure 1). But is this really the case?

Upon closer examination, however, the conflicting conclusions drawn across fields are partially the result of a focus on different levels of analyses, namely, the degree of signal variation on one hand and the degree of rule-like grammatical structure on the other hand (Table 1). Although research on animal communication in the context of the social complexity hypothesis typically focuses on signal variation (e.g., repertoire size, individuality), research on human language typically focuses on rule-governed grammatical structure (e.g., compositionality, combinatoriality). Moreover, there is no widely accepted way to measure the degree of communicative complexity in either field, nor is there agreement on what these terms represent: Different scholars emphasize different analysis units in assessing complexity (i.e., phonology, morphology, grammar, pragmatics; calls, call units, song) and also operationalize communicative complexity using a diverse set of metrics

(animal communication: Fischer et al., 2017; Peckre et al., 2019; Pika, 2017; human language: Ackerman & Malouf, 2013; Bentz et al., 2016; Nichols, 2009; Pallotti, 2015).

Crucially, although the terms "simple" and "complex" are used somewhat consistently across fields when discussing signal variability (i.e., more variation is considered more complex in both animal and human communication), they are used in exactly the opposite way when discussing rule-like grammatical structures (i.e., the existence of regular grammar-like rules for combining elements is considered more "complex" in animal communication [Bouchet et al., 2013; Engesser & Townsend, 2019; Kershenbaum et al., 2016], but "simpler" in human language [Lupyan & Dale, 2010; Wray & Grace, 2007]; discussed in the following text). In Table 1, we illustrate the different predictions made with respect to different measures of communicative complexity used across fields, define them, and underscore their nuanced points of similarity and deviation. When teasing apart these two levels of analysis and clarifying the terms "simple" and "complex" with respect to each of them, we find an interesting pattern: For signal variability, both fields are aligned with respect to terminology but partly diverge in their conclusions with regard to group size effects; for grammatical structure, the opposite holds: Both fields diverge with respect to terminology but in fact align on their conclusions with regard to group size effects (Figure 1).

## The Case of Rule-Like Grammatical Structure

Focusing on the level of rule-like grammatical structure, in the language sciences, linguistic constructions that have transparent internal structure (i.e., with syntactic rules for combining lexical signals) are considered "simple," whereas holistic and idiosyncratic linguistic constructions without an underlying syntax are considered "complex." For instance, a linguistic construction with clear-cut compositional structure for combining words/morphemes will be considered simpler than a linguistic construction in which there is no internal structure whatsoever or in which the internal structure is not transparent, such as the case of idioms or some

**Figure 1**

*The Effect of Social Complexity Across Fields and Across Different Levels of Analysis*
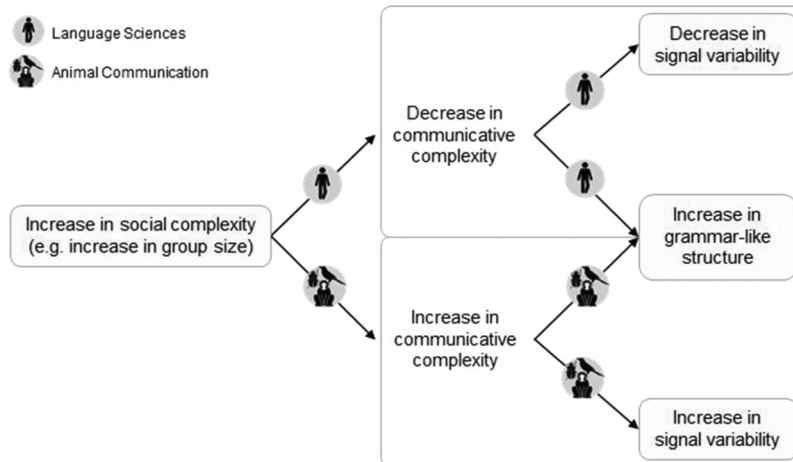
**Table 1**
*A Comparison of Communicative Complexity Measures Across Fields*

| Level of analysis | Definition | Field | Measure | Treated as |
|---|---|---|---|---|
| Signal variability | The number of distinct signals/ Signaling units | AC | Repertoire size | In both fields, larger repertoires are seen as more complex. |
| | | LS | Lexicon size/Phonological inventory | |
| | How much do signals/ Signaling units differ from one another? | AC | Gradation | In both fields, more gradation/variability is seen as more complex. |
| | | LS | Acoustic variability | |
| | How much do signals/ Signaling units differ when produced by different individuals? | AC | Individuality (gradation across individuals) | In both fields, more individuality/ Variability is seen as more complex. |
| | | LS | Talker variability | |
| Grammar-like structure | The combination of meaning-less units into meaningful units | AC | Combinatoriality | In both fields, more combinatoriality is seen as more complex. |
| | | LS | Combinatoriality | |
| | The combination of meaning-ful units into larger meaning-ful units. | AC | Combinatoriality/Compositionality | More compositionality is seen as more complex in AC, but simpler in LS. |
| | | LS | Compositionality/Syntax | |
| | The degree of predictability of form X in context Y | AC | Certainty/Degeneracy | In both fields, more predictability is seen as simpler. |
| | | LS | Conditional entropy/Systematicity | |

*Note.* AC = animal communication; LS = language sciences.

inflectional rules (DeKeyser, 2005; Hay & Baayen, 2005; Hengeveld & Leufkens, 2018). For example, the word *walked* consists of two parts: the verbal stem (*walk*) and the past tense morpheme (*-ed*), which are combined in a transparent way to express the act of walking in the past. In contrast, the irregular past form (*bought*) cannot be as easily divided into separate bits, making it more holistic and opaque. However, in the closely related field of animal communication, the terms "simple" and "complex" are typically used in exactly the opposite way when describing rule-like grammatical structure: Animal communication systems with transparent and/or compositional syntactic rules for combining signals are considered "complex," whereas holistic and idiosyncratic signals with no internal structure are considered "simple" (Pollard & Blumstein, 2012; ten Cate, 2017). For example, although most animal calls are considered to be unstructured, southern pied babblers (*Turdoides bicolor*) combine two call types (i.e., alert calls and recruitment calls) in a structured way to collectively scare away terrestrial predator (Engesser et al., 2016). Notably, this inconsistent use of the terms "complex" and "simple" across fields obscures the fact that both fields actually converge on the same pattern: For both animal and human communication systems, greater social complexity (e.g., an increase in group size) is predicted to elicit more syntactic structures, such as the existence of compositional rules for signal combinations (Bouchet et al., 2013; Engesser & Townsend, 2019; Kershenbaum et al., 2016; Peckre et al., 2019; Raviv et al., 2019; Roberts & Roberts, 2019; Wray & Grace, 2007).

The terminological discrepancy across fields with respect to the complexity of rule-like grammars is likely to stem from two different sources. First, memory limitations associated with ease of learning and use are prominent in the language sciences, whereas animal

communication studies often place their emphasis on other functional aspects. In particular, evolutionary linguists typically refer to compositional expressions as "simpler" than holistic ones because they are easier to learn (Raviv et al., 2021), can be more efficiently compressed into fewer bits (Kirby et al., 2015), and allow learners to easily derive a set of productive and generalizable rules rather than memorizing individual forms (Kirby, 2002; Zuidema, 2003). In animal communication research, however, the argument is often focused on the fact that individuals interacting repetitively with many different conspecifics need to have a more elaborate communicative system with a higher affordance for signal combinations to navigate their social environment efficiently. That is, the notion of complexity typically relies on the basic idea that compositional signals consist of many different and connected parts, rendering them less simple than an individual signal with no subparts (which is considered the simplest form of signaling). Notably, both reasonings make sense and in fact resonate with the two typical dictionary definitions given to the term "complexity" in English: (a) "composed of two or more parts" and (b) "hard to separate, analyze, or solve" (Merriam-Webster; Pallotti, 2015). Evidently, the animal communication literature often treats grammatical-like structure as more complex based on the first definition of complexity (i.e., having more than one part), whereas the language sciences often treats grammatical-like structure as simpler based on the second definition of complexity (i.e., it is easier to learn).

A second source for the discrepancy in definitions across fields is that terms such as "complex" and "simple" also carry a loaded social baggage, which invites further subjective associations that can be interpreted differently across contexts. For some, the notion of "simple" is associated with something "superior" (e.g., being more

elegant, optimized, efficient), whereas for others, the notion of "simple" is associated with something "inferior" (e.g., being less sophisticated, unrefined). Unsurprisingly, terms such as "complex" and "simple" have been used in the past to make potentially harmful and politically charged judgments on the nature of languages used by different communities, that is, that some languages are "better" than others because they are more complex. The same holds for cross-species comparison, harking back to pernicious concepts such as *scala naturae*, where human languages are often considered "better" than other animal communication systems because they are more complex (Petkov & Jarvis, 2012). This also relates to the fact that full-blown grammar-like structures are arguably absent (or at least very rare) in animal communication systems (Collier et al., 2014); albeit when found, they are found in highly social animals.

## The Case of Signal Variability

Focusing on the level of signal variability, here the literatures on animal communication and human language are consistently aligned in their terminologies when defining complexity. Specifically, in both fields, a system with more cross-individual and inter-individual variations is seen as more complex, and a reduction in signal variability (and consequently, a reduction in the total number of unique signals) is seen as simpler (Bouchet et al., 2013; Freeberg et al., 2012; Gil, 2008; Raviv et al., 2019). In other words, both human and animal communication systems are seen as more complex if they consist of bigger and/or more heterogeneous signal repertoires. Upon closer scrutiny, however, it appears that despite this convergence on terminology, the two fields somewhat diverge in their conclusions with respect to the effect of social complexity: An increase in animal group size is typically associated with more signal variation (e.g., primates: Dobson, 2009; McComb & Semple, 2005; rodents: Lima et al., 2018; Pollard & Blumstein, 2011; bats: Knörnschild et al., 2020), whereas an increase in human group size is typically associated with less lexical and acoustic variation among speakers (Dachkovsky et al., 2018; Meir & Sandler, 2019; Meir et al., 2012; Raviv et al., 2019; Reali et al., 2018).

For instance, animal call repertoire size is positively correlated with group size across 42 primate species (McComb & Semple, 2005), and there is a positive relationship between vocal variation and social group size across 24 bat species (Knörnschild et al., 2020). The explanation for this trend is that individuals living in larger groups are likely to be involved in a wider range of interactions with more diverse social partners, ultimately triggering the need to transmit a broader diversity of information and to express a wider range of emotional and motivational states (Freeberg et al., 2012; Ord & Garcia-Porta, 2012; Roberts & Roberts, 2019). In this sense, larger repertoires of distinct signals allow for this flexibility. Moreover, the more group members there are to interact, the more they may benefit from accurately recognizing the sender identity of a signal (Pollard & Blumstein, 2011). But as the number of individuals that must be discriminated increases, the more this recognition task becomes difficult. This greater difficulty is thus expected to drive selection for a higher level of signal variability. In other words, greater signal variability is advantageous for individuation, and the pressure for individuation is expected to increase as group size grows. This is particularly true for affiliative signals that are used in many contexts and are

usually the focus of the "social complexity hypothesis" (Bouchet et al., 2013; Griebel & Oller, 2008; Keenan et al., 2013; Lemasson & Hausberger, 2011; Snowdon & Hausberger,' 1997).

In contrast, studies on emerging sign languages suggest that languages that evolved in bigger communities are more lexically uniform compared to languages that evolved in smaller communities, despite the fact that these languages are of the same age and evolved around the same time (Dachkovsky et al., 2018; Meir & Sandler, 2019; Meir et al., 2012). Although the languages of bigger communities should be more variable by default (given that the number of potential variations and innovations is inherently dependent on the number of individuals), they display a surprisingly high degree of lexical convergence, with most words having a single conventionalized form (i.e., low talker variability). This is indeed the case for a sign language that emerged in the bigger community (i.e., Israeli sign language). In contrast, a sign language that emerged in the smaller community (i.e., Al-Sayyid Bedouin sign language) displays a great deal of lexical and sublexical talker variation: For the same sign, the exact location and shape of the hand can vary a lot from signer to signer, and different signers often use completely different signs to express frequent concepts (e.g., some compound signs were reported to have up to six different variants in a group of eight people). The explanation for this trend is that members of larger communities are under a stronger pressure to reduce variability and to converge on a shared lexical form, seeing as they are often less familiar with one another and typically share less common ground, which they nevertheless need to overcome to successfully communicate with each other (Raviv et al., 2019; Thompson et al., 2020). In other words, the focus here is on the idea that reduced signal variability is advantageous for convergence, and the pressure for convergence is expected to increase as community size grows.

One likely reason for why signal variability is treated so differently across fields (i.e., more variability is beneficial for animals, but problematic for humans) may be the reliance on meaning in the domain of human language. Although in linguistics, the number of lexical or acoustic variants is counted for a specific referent, in animal studies, this is typically not possible to do due to our limited ability to access the potential meanings of animal signals. As Prat (2019) put it, "*identifying semantics, or meaning, in nonhuman animal communication is probably the most difficult task [. . .] because of our limited ability to infer the real goals and intentions of nonhuman animals.*" As such, the degree of signal variability in animal studies is merely based on counting the total number of unique acoustic/visual signal variants based on distinctive features, without any association or treatment to their potential meaning. This type of signal variability measure is less in line with the degree of lexical variable discussed earlier in the language sciences. Instead, it more closely resembles measures related to the size of human languages' phonological inventory (Table 1). Indeed, when focusing on a meaning-free measure of phoneme inventory, human languages do seem to show similar patterns as animal communication systems with respect to signal variability, where bigger communities typically display larger phonological inventories (Hay & Bauer, 2007; Wichmann et al., 2011).

The problem of detecting meaning in animal communication systems might also amplify the difficulty in detecting grammatical structure in them: Although terms such as syntax always deal with combinations of *meaningful* units in human languages, in animal

studies, it has been used more generally to describe any combination of units, even meaningless ones (Engesser & Townsend, 2019; Suzuki et al., 2019). This type of so-called syntax is actually referred to as "phonology" or "combinatorial structure" in human linguistics, that is, the combination of *meaningless* sounds into a meaningful unit (i.e., word)—and not as syntax in the most classic sense of the word (Table 1). In other words, although the terms compositionality and combinatoriality have been used interchangeably in the field of animal communication, they typically represent different levels of analysis in human languages. Without a clearer grasp of the potential meanings of different animal signals, assessing the degree of grammar-like structure (compositional syntax) as opposed to combinatorial phonology is extremely difficult to do (Collier et al., 2014; Engesser & Townsend, 2019).

## Conclusion

Taking the specific example of the impact of social complexity on communicative complexity, we showed that the different conclusions reached in the fields of animal communication and human linguistics can be largely attributed to misaligned terminology. Considering the picture painted earlier, we suggest moving away from general and potentially inconsistent terms such as "complex" and "simple," which may obscure interesting patterns across fields. Instead, we advocate for formulating theories using specific, neutral, and descriptive terms such as those given in Table 1 (e.g., compositionality, repertoire size), which can be applied uniformly across species. For instance, looking at compositionality allows for a direct comparison between human and animal communication systems, leading to more productive cross-disciplinary dialogue (Jaber et al., 2021; Townsend et al., 2018). In sum, we wish to encourage researchers from both disciplines to work more closely together, using similar terminologies and analyses to examine cross-species similarities and differences, placing the study of communication at large in an evolutionary comparative framework.

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