Researchers decipher small Dead Sea mammal's vocal communication

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Rock hyrax mother and pups. Credit: Yacov Ben Bunan

In nature social living is strongly connected to the ability to communicate with others. Maintaining social ties and coordinating with group mates require frequent communication. Therefore, complex social

systems are usually associated with well-developed communication abilities. The apex of communication complexity is undoubtedly human language. However, intensive and informationally rich communication comes at a cost in terms of time spent transmitting information and muscular effort invested in articulating signals.

In the 1930s American linguist George Kingsley Zipf popularized this concept by articulating the Law of Brevity, a linguistic rule stating that word length is negatively correlated with its frequency of use in language. This principle was verified in almost a thousand languages and is regularly observed in the process of language evolution, where frequently used long words are often shortened, such as television to TV. Thus, while signalling systems have improved, informational content has been preserved.

Does the existence of the Law of Brevity in human language stem from the evolutionary origins of animal communication? The relationship between call duration and usage frequency has been tested in several animals, but results differed between species. A proposed explanation for the lack of a clear fit of animal repertoires to the brevity principle is the abundance of long-range calls. Humans mostly communicate within short range (

Rock hyrax, Ein Gedi, Israel. Credit: Yacov Ben Bunan

With this in mind, researchers set out to examine whether call amplitude, rather than call duration, might be the main factor by which animal vocal repertoires are optimized. By adopting the "least-effort" logic, i.e., frequent calls should require the least effort to produce, they hypothesized that softer calls would be more frequent than louder ones.

The researchers tested this in rock hyraxes, a medium-sized mammal native to Africa and the Middle East. Rock hyraxes live in groups of up to 30 comprised of multiple females and their offspring, and usually with just one adult resident male. Within the group, hyraxes frequently communicate, using an extensive repertoire of calls. But the bachelor

adult males, who lead predominantly solitary lives, interact with females only briefly during the short mating season and with other males mainly through aggressive encounters. Males frequently sing complex and loud self-advertisement songs, transmitting their individual quality to both females and neighboring males.

The hyrax population studied lives in the Ein Gedi Nature Reserve near the Dead Sea in Israel. Since 1999 this wild population has been monitored continuously as part of a long-term study of hyrax behaviour and communication led by Prof. Eli Geffen, of Tel Aviv University, and recently also by Dr. Amiyaal Ilany and Prof. Lee Koren, of the Mina and Everard Goodman Faculty of Life Sciences at Bar-Ilan University. As part of this study, 19 male and female hyraxes were fitted with individual, miniature audio recorders and all of their calls were logged for approximately one week. By listening and labelling all recorded calls, the researchers created full rock hyrax vocal repertoire. Using this extensive dataset, they calculated usage frequency of all call types and measured the average duration and amplitude for each one. This allowed them to examine if hyrax vocal repertoire corresponds with the classic Law of Brevity (call duration/usage) relationship, or, whether the optimization factor of the vocal performance is call amplitude.

In their study, just published in the journal *Evolution Letters*, the researchers demonstrate how changing necessities can affect the development of different voices for various purposes, and provide clues as to how the complexity of human language began to develop. They compared male and female repertoires and found that females produce more call types in general and more affiliative call types, such as a coo, in particular. According to one of the study's lead authors, Dr. Amiyaal Ilany, of Bar-Ilan University's Mina and Everard Goodman Faculty of Life Sciences, this was not surprising, as hyrax females maintain stable social relationships within a group, while bachelor males have only limited communication opportunities.

The research team, which included Dr. Vlad Demartsev and Naomi Gordon, also discovered sexual differences in relation to the Law of Brevity. In females, longer calls are actually the more frequent ones, in contradiction to the Law of Brevity's prediction. In contrast, amplitude seems to follow the "least effort" paradigm, as soft calls (requiring less effort to produce) are more frequently used. The male repertoire, on the other hand, is characterized by minimized duration, as well as amplitude. Male vocalizations are heavily influenced by the unique requirements of their self-advertisement songs, which must be loud in order to reach remote listeners.

"This raises the question of why human language isn't optimized by amplitude," says Dr. Ilany. "Could it be because the development of artificial signaling means for long-range communication made high amplitude calls less needed? Perhaps the high pressure for increased informational content in the emerging human languages capped the amplitude of the vocal signals, as loud calls have less capacity for informational content. Both scenarios could lead to duration-based optimization that is now widespread," he added.

More information: Vlad Demartsev et al, The "Law of Brevity" in animal communication: Sex-specific signaling optimization is determined by call amplitude rather than duration, *Evolution Letters* (2019). DOI: 10.1002/evl3.147

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