

REVIEW

Communicative efficiency: challenges and trends

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ABSTRACT

This text is a review of the lecture entitled *Communicative efficiency, information theory and the limits of human mind* delivered by Dr. Natalia Levshina at Abralín ao vivo – Linguists online event on July 6th, 2020. Through her talk, the lecturer seeks to problematize the issue of communicative efficiency and its relationship with information theory and pragmatics, using linguistic examples both from human speech and artificial languages. At the end of her argumentation, the researcher talks about challenges and points out some possible solutions for the development of communicative efficiency theory using for that experiments with artificial language learning.

RESUMO

Neste texto, resenha-se a conferência da pesquisadora Dr.^a Natalia Levshina intitulada *Eficiência comunicativa, teoria da informação e os limites da mente humana* proferida no evento Abralín ao vivo – *Linguists online*, no dia 06 de julho de 2020. A conferencista, por meio de sua fala, busca problematizar a questão da eficiência comunicativa e sua relação com a teoria da informação e a pragmática, utilizando exemplos linguísticos tanto da fala humana quanto de línguas artificiais. Ao final de sua arguição, a pesquisadora discorre sobre desafios e aponta possíveis soluções para o desenvolvimento da teoria da eficiência comunicativa utilizando para tanto experimentos com a aprendizagem de línguas artificiais.



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PALAVRAS-CHAVE

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This review talks about the lecture entitled *Communicative efficiency, information theory and the limits of human mind*¹ delivered by Dr. Natalia Levshina at Abralín ao vivo – Linguists online event on July 6th, 2020 and mediated by Dr. Guilherme Garcia. The lecturer organizes her talk in three sections: presents what communicative efficiency is pointing out two types of costs involved (articulatory and processing) and how information theory is related with them; she talks about aspects related to pragmatics on communicative efficiency; and she ends her talk with challenges and solutions for the development of the communicative efficiency theory.

Firstly, Levshina defines efficiency as the ration between costs (articulation and processing, for example) and benefit (successful transfer of a message). Regarding the information theory, the lecturer points out that a language is efficient when it enables the speaker to transmit a message using minimal effort, she also states that when a message is predictable, less code may be used. Predictability is measured by the informativeness of a content, which may be obtained by the expression $I = -\log_2 P(x)$. Levshina explains that the word “piano”, for example, is less informative and more predictable than “harpsichord” because its probability of occurrence is higher than that of “harpsichord”. In the contextual level (how informative is an element in a certain context), the sentence “I’d like a glass of wine” is less informative and more predictable than “I’d like a glass of cyanide”. The examples demonstrate that there is a relationship between information theory and communicative efficiency, i.e., a system or linguistic use is efficient if the correlation between effort (formal length) and informativeness is positive. It is worth noting that this correlation must be statistically strong too, i.e., its correlation coefficient value must be close to +1.0.

Levshina presents Zipf’s law, in which more frequent words tend to be shorter, such as “watch”, which is more frequent and shorter than “gongoozle”. The researcher reinforces this law with Bentz and Ferrer-i-Cancho’s (2015) study, in which more than 1,000 languages presented a negative correlation between word length and its frequency of use. Levshina concludes that Zipf’s law is synchronically universal, proving her point with *Klingon*², showing through a scatter plot that the length of words in *Klingon* also negatively correlates with frequency of use.

However, Levshina points out that it is not only frequency that determines the length of words. She presents the results from Piantadosi *et al.* (2011), in which the correlation between informativeness and word length is stronger than length and frequency of use in European languages. Levshina also presents the relationship between markedness and frequency of use. For the lecturer, markedness is a matter of efficiency, not frequency, exemplifying it with the words “book” and “books”, in which the plural mark in the second word makes it longer, thus more informative and more efficient, even though it is less frequent. For Levshina, this is a local effect, since it does not happen with all nouns in all languages, such as English, in which the plural form “blueberries” is longer, more frequent but less informative than its singular form, being thus less efficient.

1 The original title was changed for this one on the day of the lecture, as in the author’s slides.

2 Artificial language used in Star Trek movie franchise.

In order to end the issue of articulation, efficiency, and information theory, Levshina presents the morphosyntactic variation, in which there are efficiency patterns. The lecturer mentions the variation in case markedness in Kurumada and Jaeger's (2015) study about Japanese language. In this language, the object marker is more frequently omitted³ in typical constructions (when the object is inanimate).

About processing and efficiency, Levshina discusses word order. The researcher argues that there is evidence that language users tend to reduce the dependency length between syntactically related words, allowing for more efficient parsing and generation of natural language. In order to illustrate that, the lecturer mentions the "short before long" pattern in VO languages, as in the sentence: "I've read with great interest your article about classifiers in Sinitic languages [...]", in which the short complement "with great interest" precedes the long complement "your article about [...]", reducing the processing costs. This fact may also be seen in Rayan's (2019) study, which shows evidences that prosodic end-weight favors the positioning of heavier components in the end.

Levshina reinforces her point displaying a graph based on data from the Universal Dependencies corpora in which many European languages shared a probabilistic tendency of more than 50% of realization of the pattern V+short PP+long PP. For example, in "I would like to thank you for coming here to visit me.", the longer prepositional phrase "for coming here..." is positioned at the end. The lecturer uses *Yodish*⁴ as an example of the dependency length of words in sentences and its relationship with efficiency in artificial languages. In "Rest I need", the dependency length between the object and the verb is twice as much the dependency length between the subject and the verb. In the standard version "I need to rest", however, the lengths are equal. After analyzing original and standardized scripts for five *Star Wars* movies, the researcher demonstrated that the frequency of occurrence of lower dependency lengths tends to be higher in standardized *Yodish* than in the original *Yodish*, revealing that human English tends to be slightly more efficient than *Yodish*.

In the second section of her talk, Levshina relates pragmatics and efficiency through the Rational Speech Acts theory. Under this perspective, speakers act rationally and efficiently (the speaker makes choices based on the probability of a literal listener be able to correctly understand him/her), and the listeners infer the state of the world through Bayesian inference from whatever the speaker says. Levshina argues that it is possible to measure communicative utility/efficiency when subtracting speakers' communicative costs (time and effort) from speakers' benefits ("how certain the listener will be about the intended world after hearing an utterance").

In the last part of her talk, Levshina discusses challenges and possible solutions for communicative efficiency. The first challenge discussed is the relationship between efficiency and discourse: in a non-verbal communication, in which there is no need for being explicit, it is not clear how to measure efficiency, revealing that it is necessary to build a theoretical framework and tools to include predictability in this kind of situation in an information theory approach. This happens

³Inanimate noun, object mark (-o) is absent: Sensei-ga shobosha(ø) ekimae-de mi-ta-yo. (The teacher saw a fire-engine near the train station.) (KURUMADA; JAEGER, 2015, p.156).

⁴ Artificial language used by Yoda in Star Wars movie franchise.

because the correlation between the degree of explicitness and the mental activation and access to the referent is negative. For instance, when speakers introduce a new referent in discourse as in “Did you know that Joana, the teacher of English, was fired?”. In this sentence, a semantically rich expression “the teacher of English” was used because the activation and the mental access to the referent were low.

Two other challenges discussed by the lecturer concern the extent to which language users are really rational and the variability of the pragmatic reasoning. Levshina mentions Qing and Franke (2015) and Sikos *et al.* (2019) who offer models that have better explained rationality when using salience. For Levshina, considering only the literal listener and adding salience to the object (there are objects which are more salient than others) make the model simpler and more useful.

Regarding variability, based on Franke and Degen (2016), the lecturer claims that some humans are not good at recursion. She reinforces her argument presenting Valangendonck *et al.*'s (2016, 2018) experiment, in which it was observed that the speaker does not always formulates his/her speech to favor the listener, revealing that users are not always rational and cooperative.

Levshina also points out as challenge the egocentric speaker. She first presents two aspects of phonetic reduction: it does not depend on the listener (it depends on frequency and informativeness), and it is not always adjusted in relation to the listener, depending on semantic and discourse predictability. Secondly, the researcher points out the relationship between the egocentric speaker and grammatical variation, mentioning Ferreira and Dell's (2000) results, in which the complementizer “that” is used when it is followed by a less accessible word, not to avoid ambiguity.

Then, the lecturer relates efficient word order with the egocentric speaker through two factors: a) the principle of information locality, in which syntactic related words tend to be placed next to each other and b) the iconicity of contiguity, in which forms that are semantically related tend to occur next to each other. For Levshina, then, it seems that this reduction tendency would only be related to the speaker.

Levshina also presents alternative explanations for Zipf's law and for the markedness phenomenon. Regarding the first one, she presents Miller's (1957) counter-argument, for whom similar results to Zipf's could be found with monkeys. In order to perform the experiment, random letter typing and white space character with a pre-determined probability would be enough. This is what Lavshina did, and she compared the frequency of the character length in the random typing with Donald Trump's tweets. In the random typing experiment, the correlation between the frequency and the character length was weak. On the other hand, on Trump's experiment, it was strong, evidencing that humans are less efficient than monkeys⁵.

For the markedness phenomenon, Levshina pointed out that Cristofaro (2019) observed that plural constructions were not consequence of the need to disambiguate but a syntactic need, as in

⁵ The researcher uses this term as a reference to the random typing and to Miller's argument (1957), emphasizing that she did not use monkeys in her experiment.

distributive and partitive constructions and expressions of multitude. However, the lecturer remarks that this point of view excludes languages in which the plural form is not marked.

Due to these challenges, the researcher questions if efficiency constraints are only defined by the audience, or if they would be consequences of other cognitive or historical pressures. A possible solution for that, according to Levshina, would be the experiment with artificial languages. She describes her own study in 2019 with causative constructions. The results of this study revealed that language users described more frequent causative events with shorter forms with more frequency. On the other hand, rare events were described with longer forms, changing the learned language, making it more efficient.

From all that was said, Levshina concludes: a) that it is necessary to distinguish the efficient use of a language from the use of a language based on efficiency principles, and to show cases where these two perspectives overlap; b) that the experiment with artificial language learning may contribute to test the potential of causative forms controlling for predictability and frequency; c) that information theory must find ways of including other modal sources; and d) that users' rationality is overrated.

In a thorough way and with accessible examples to the audience, Levshina is able to problematize the issue of communicative efficiency, showing well established theories in the field, at the same time questioning them. She also points to areas that could be explored as multimodality in information theory and the rational speech act theory. Besides, the lecturer presented, with evidence from recent studies, how experiments with artificial language learning may contribute to overcome certain challenges, such as the control for variables as rationality, predictability, and context.

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