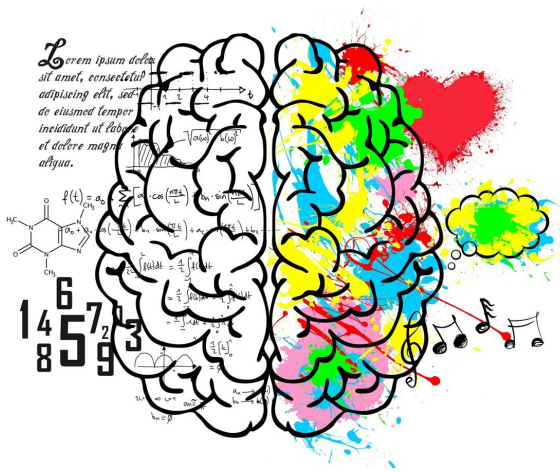


# New research reveals tradeoff between complex words and complex grammar in sentences

20 June 2022, by Mike Morrison



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How does one brain network compensate for another when parts of the brain are damaged by illness or injury?

A new study of patients with [primary progressive aphasia](#) (PPA) shows that patients who have difficulty producing complex words due to [brain injury](#) will compensate for this by stringing together a series of simple words that convey the same idea.

The researchers also found a similar tradeoff between the complexity of words chosen and syntactic complexity (how words are structured to convey meaning) in healthy volunteers—suggesting a basic property of language production is maintaining a balance between the complexity of words and syntax.

The team, which includes investigators from Massachusetts General Hospital (MGH), Harvard University and the Massachusetts Institute of

Technology (MIT), published their findings in the *Proceedings of the National Academy of Sciences* (PNAS).

During language production, speakers turn complex thoughts into a linear sequence of words, choosing both the words themselves and the syntactic structure of phrases that determine the order and relationship of the words.

PPA is a condition caused by the gradual degeneration of brain cells, leading to lesions in the brain that affect the patient's ability to communicate. Depending on the primary site of the lesion, some PPA patients have trouble accessing words, while others have trouble processing grammar.

Clinical observations of PPA patients have suggested that patients who have trouble accessing words may produce long descriptions of their thoughts, while patients who have trouble processing grammar may choose more precise words.

For example, if a patient has difficulty saying, "a sailboat," they might produce an utterance that has a more complex syntax but simpler words such as, "the thing that is moved by the wind on the water."

But these observations had not been confirmed through research or identified in healthy volunteers.

To address these challenges, the researchers first developed a new frequency-based method for characterizing the syntactic complexity of utterances in naturalistic speech.

They then tested whether lexical and syntactic complexity, as measured by the frequency of their use, trade off in a large sample of PPA individuals

asked to describe a picture of a family at a picnic. (Image description is a common diagnostic tool for PPA).

Finally, the team tested the generalizability of this syntax-lexicon tradeoff in a large sample of healthy speakers taking part in the same picture description task.

Unlike PPA patients, healthy individuals can shift between the use of complex syntactic or complex lexical items, perhaps depending on what is more accessible in the moment or what might facilitate comprehension.

The results showed that if a sentence is syntactically complex, it likely incorporates simple words. On the other hand, if a sentence contains more complex words—such as words that are not commonly used—its syntax is more likely to be simple.

"By gaining insight from patients with PPA, this research reveals a basic property in language production—i.e. the maintenance of a balance between the complexity of words and syntax," says Neguine Rezaii, MD, a physician-investigator in the Frontotemporal Disorders Unit in the Department of Neurology at Mass General and the lead author of the study. "This work also emphasizes the central role of communication by showing that the brain seems to be equipped with various strategies that PPA patients can use to get across their meaning."

"Future work is needed to elucidate the mechanism that drives this tradeoff," adds Edward Gibson, Ph.D., professor in the Department of Brain and Cognitive Sciences at MIT and the senior author of the study. "One possibility is that there might not be enough capacity to construct a sentence by using both syntactically and semantically complex items."

In the meantime, this novel metric developed by the team to measure syntax complexity can now be applied in further studies in the [clinical setting](#) to see if it may provide a more accurate description of language deficits in patients neuropsychiatric disorders.

"We are moving beyond simplistic descriptions of

patients' difficulties with communication such as 'fluent' or 'non-fluent' aphasia," concludes Brad Dickerson, MD, professor in the Department of Neurology at Harvard and Director of the Mass General Frontotemporal Disorders Unit. "This work highlights the importance of quantifying the ways patients use words and sentences to communicate thoughts. We plan to harness these methods to evaluate emerging treatments for patients with PPA with the ultimate goal of helping them communicate better for longer."

**More information:** Neguine Rezaii et al, A syntax–lexicon trade-off in language production, *Proceedings of the National Academy of Sciences* (2022). [DOI: 10.1073/pnas.2120203119](https://doi.org/10.1073/pnas.2120203119)

Provided by Massachusetts General Hospital

APA citation: New research reveals tradeoff between complex words and complex grammar in sentences (2022, June 20) retrieved 7 November 2022 from <https://medicalxpress.com/news/2022-06-reveals-tradeoff-complex-words-grammar.html>

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