Reading comprehension not worsened by noise, study finds

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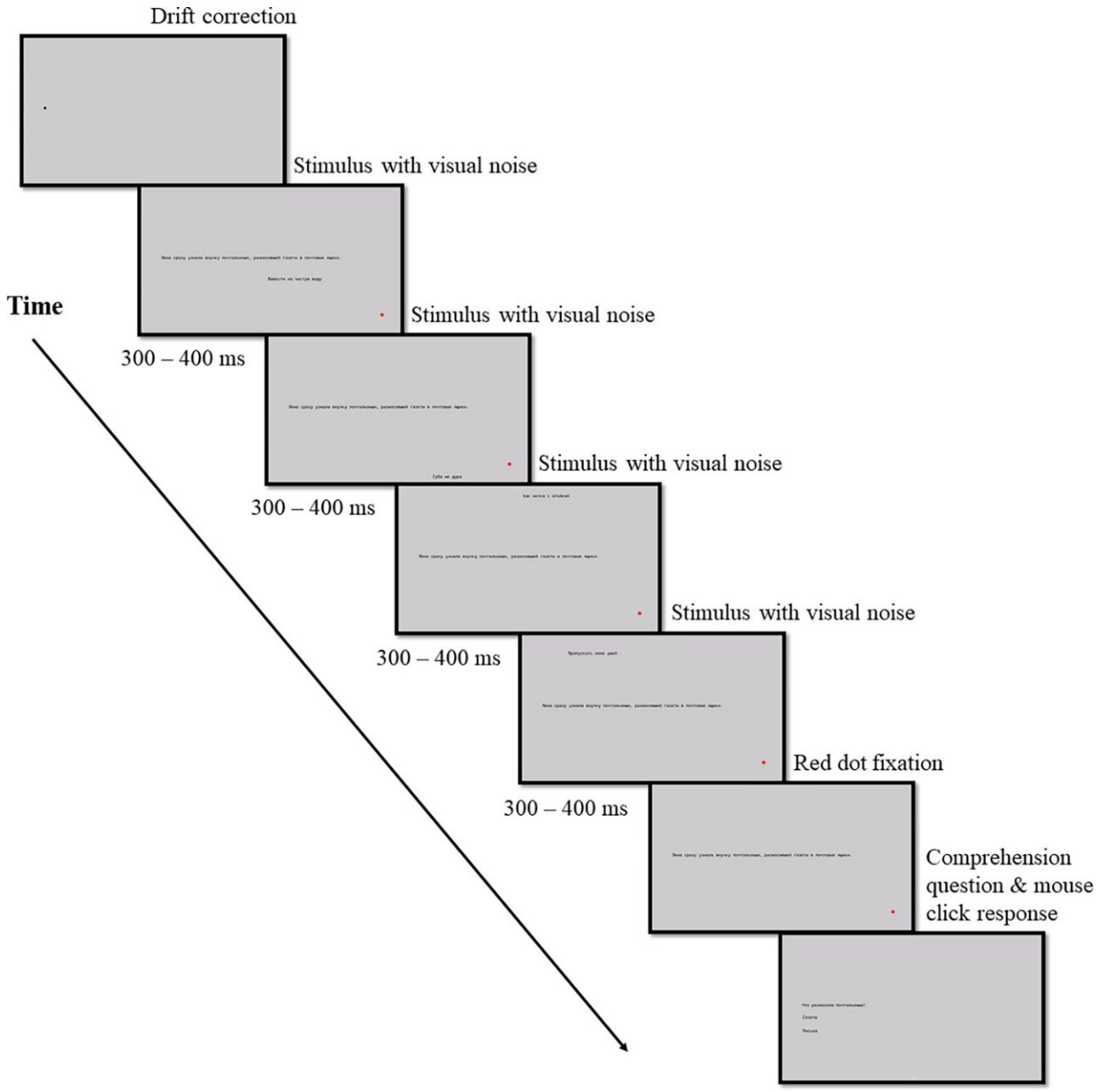

An experimental trial with visual noise. Credit: Zdorova N, et al. Do we rely on good-enough processing in reading under auditory and visual noise? *PLoS ONE* 18(1): e0277429

Researchers of the HSE Centre for Language and Brain have investigated the impact of both auditory and visual noise on semantic processing during reading to determine if it results in a more superficial reading style that emphasizes the meanings of individual words over connections between them in a sentence.

It appears that noise does not affect reading comprehension but can cause a decrease in reading speed when even unintelligible conversations are occurring nearby. However, when exposed to visual noise, individuals tend to read slightly faster, possibly due to the irritating nature of the noise. The study findings have been published in *PLOS ONE*.

In the theory of communication, noise is considered an inevitable aspect of the communication process. Broadly speaking, noise refers to any disturbance in the communication channel or any extraneous signal that interferes with the intended signal. Some examples of noise include advertisements on a website, nearby conversations, music, street performers like jugglers or dancers in a park, and so on.

Noise can be either internal, resulting from conditions such as disease, aging, or brain damage, or external, originating from the environment. External noise can vary in modality, such as auditory or visual, and may or may not match the modality of the target signal. "Background noise in the street matches the modality of having a conversation but conflicts with the modality of reading a book," the authors explain.

Previous studies reported negative effects of both auditory and visual noise on reading fluency and comprehension. However, their findings do not present a comprehensive picture.

Thus, studies of eye movements found longer fixations, a greater number of regressions and hence longer reading times when subjects were exposed to intelligible or unintelligible background speech. Additionally, older readers took longer when faced with non-linguistic visual noise, such as a certain type of font or blurred script.

A negative impact on reading speed due to linguistic visual noise, such as short phrases appearing on the screen alongside target sentences, was also observed.

The impact of noise on reading comprehension can differ based on whether it is visual or auditory. Available evidence suggests that visual noise does not interfere with reading comprehension, while auditory noise may or may not affect comprehension.

In particular, comprehension was found to be disrupted by background unintelligible speech, music with lyrics, and non-preferred background music. However, intelligible speech and bar-type noise did not seem to affect comprehension.

According to the authors of the new paper, none of the studies investigating the effect of noise on reading have considered it in the framework of language processing models.

Thus, according to a noisy-channel model, when reading under noisy conditions, people tend to process language at a surface level and rely more on the meaning of individual words rather than the way words are arranged in a sentence. This is to say, the authors explain, readers in a noisy environment attempt to infer the relationships between words

based on the meanings they convey.

On the other hand, the "good-enough" sentence processing model places a strong emphasis on semantic plausibility, ie on whether the text makes sense, as a key factor in sentence comprehension, regardless of any distracting noise. When a person encounters a sentence, two mechanisms of sentence processing are triggered in their mind simultaneously: a bottom-up, syntactically based algorithmic process and a top-down, semantically based process.

"Semantically based processing can be completed faster if the representation is semantically plausible and aligns with the person's real-world knowledge. By placing less emphasis on syntactic processing, readers may be conserving their cognitive resources," the authors explain.

This assumption was confirmed in experiments using semantically implausible sentences, for example, "The dog was bitten by the man" or "The fox that hunted the poacher stalked through the woods." Despite grasping the meanings of individual words, the subjects often failed to comprehend the true meaning of the entire phrase and thus missed the absurdity of the sentences and their inconsistency with the real world.

Based on the above theoretical concepts and experimental evidence, good-enough processing prioritizing semantic information can be expected in noisy conditions of various types. The objective of the new study was to explore whether auditory and visual noise would result in a greater reliance on semantics during language processing—in other words, whether reading can become more superficial in a noisy environment.

The researchers conducted two experiments. The first experiment involved 38 women and 33 men with a mean age of 22 years, no vision

or hearing problems, and no history of neurological or mental disorders.

The subjects were asked to read Russian sentences containing a participial clause. The syntax of the experimental sentences was manipulated to make some of them plausible, such as "Dima worked with the president's doctor treating small children," and others implausible, like "Dima worked with the doctor of the president treating small children." Each experimental sentence was followed by a comprehension question.

The researchers utilized an eye-tracking device to monitor reading fluency. The background noise used in the experiment consisted of a three-talker babble created by overlapping and merging Russian-language popular science podcasts. All non-speech sounds (such as music, crackling or rustling) were edited out. Each participant read the experimental sentences (which were presented in a randomized order) twice—once with noise and once without noise.

The second experiment involved 30 women and 40 men with a mean age of 23 years. None of them participated in the auditory noise experiment. The equipment and stimuli were identical to those used in the first experiment, but this time, the noise was visual and consisted of short Russian idioms and set phrases, two to five words in length, which appeared next to the target sentence on the screen, for example, "a carriage and a small trolley" ["tons of something"] and "making an elephant out of a fly" ["exaggerating"].

The results of the first experiment showed that auditory noise affected the overall reading speed. The background babble caused longer fixation on the participial phrase and its preceding word. According to the researchers, longer initial fixations apparently compensated for the noise-induced cognitive load. The equally good comprehension in the presence of auditory noise observed in this study is consistent with the findings of

previous studies that used bar-type noise, but contradicts those that used non-preferred music.

In the second experiment, the researchers found a paradoxical increase in the overall reading speed when visual noise was present. "The increase in reading speed may have been driven by the participants' desire to complete the task quickly, possibly due to the discomfort caused by the visual noise during reading," say the authors.

At the same time, no significant effect of noise on comprehension accuracy was found. The study participants were able to read sentences even faster while preserving a high comprehension rate in the presence of visual noise.

The findings of this study partially confirm those of earlier studies. Indeed, semantic processing is faster than syntactic processing for sentence comprehension. But neither auditory nor visual noise increased the readers' reliance on semantics, meaning that their reading did not become more superficial.

These results, observed for the first time, do not support either the "noisy-channel" or the "good-enough" processing models. According to the authors, this inconsistency does not necessarily indicate that the models in question are incorrect, but rather that further study on this topic is warranted.

More information: Nina Zdorova et al, Do we rely on good-enough processing in reading under auditory and visual noise?, *PLOS ONE* (2023). DOI: 10.1371/journal.pone.0277429

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