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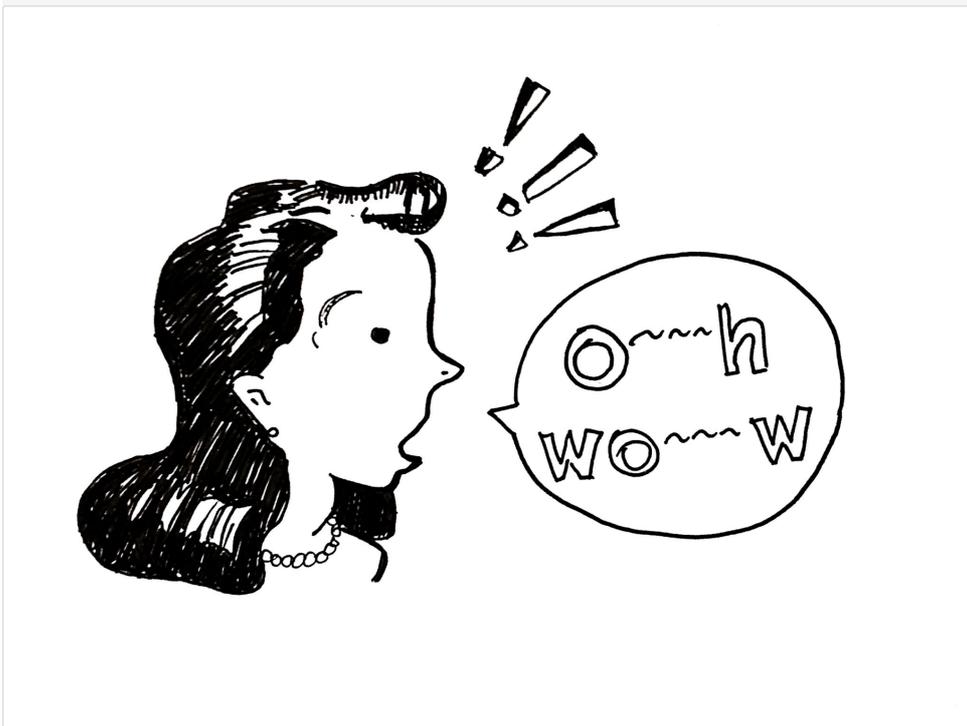


POTENTIALISM THEORY

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Researchers find that surprise and entropy lengthen vowels

JOSH PURTELL | NOV 14, 2017
CONTRIBUTING REPORTER



Yale linguistics professor Jason Shaw, together with Keio University professor Shigeto Kawahara, has determined that surprisal and entropy prolong the length of vowel sounds in Japanese. The paper, which was published in Sage Journals on Nov. 5, found that the predictability of a vowel affects its duration in spoken Japanese, as is the case in English. This discovery lends support to the idea that surprise universally impacts human language.

“Human languages are optimized for efficiency,” Shaw said. “If a vowel is inferred, it doesn’t have to be communicated as robustly. Conversely, if something breaks the mold, then it is typically emphasized.”

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The researchers looked into two qualities of a word's sound, surprisal and entropy. These two qualities can be used to assess the predictability of a particular sound. If a vowel is unlikely — a characteristic described by entropy — or if it is unexpected — described by surprisal — then it will be longer in duration, Shaw said.

While these two characteristics play a role in every language, they are influenced to a great degree by the speaker's own language.

"There are phonotactic constraints in any language — in English, if a word begins with a 'p' sound, the probability of a 't' following is zero," Shaw said. "When we examined the corpus of the Japanese language, we found that you can't expect vowels [to occur] with equal probability — there's this gradient of probability."

Because length is inversely proportional to local predictability, Shaw said, vowels tend to be short when they are predictable, noting that it is common in English to pronounce contextually obvious words and syllables more softly than usual. For example, the second "well" is almost not pronounced in the expression "all's well that ends well" because it is obvious and does not need the same degree of verbal emphasis that the first "well" required, Shaw explained.

The Japanese language is unique among languages because it uses a unit called a mora. In a mora, the duration of the consonant-vowel sequence is kept relatively constant, Shaw said. By studying how surprisal and entropy — called information-theoretic considerations — affect vowel duration in a language where vowel duration is governed by a mora-timing, the researchers hoped to gain more insight into how surprisal and entropy influence speech in all languages.

"Our results show that there are other grammatical considerations that need to be taken into account, and it is most productive to explore the interaction of grammatical factors as well as information-theoretic factors," Kawahara said.

Beyond just confirming the phenomenon of lengthening due to surprisal, Shaw and Kawahara investigated the cognitive mechanisms that may underlie these patterns. The most promising explanation, said Shaw, is competition.

"When we try to make a sound, we have to select between many different [possible] movements, and each choice increases the competition," he said, adding that there is evidence that people don't fully decide what to say before beginning to speak. This stage, at which planning and executing can become disrupted, explains speech errors, he added.

Even on a subconscious level, the human mind still considers rules that govern sequences of sounds in language in which it is working.

"If we want to say praise, we might mess up and say 'plaise,' but we

would never have said ‘ptaise,’” Shaw said, noting that “ptaise” would be possible in other Indo-European languages. This is where linguistic surprisal and entropy play a role: Vowels sound longer because it takes the brain longer to determine which vowel it uses.

Humans have evolved to associate this delay with informational significance, Shaw said, but fundamentally this is just a “happy consequence ... primarily, the slowdown is caused by the cognitive stress on the speaker.”

This cognitive stress manifests itself physically — and sonorously. As the mind resolves which vowel it will articulate, the tongue is drawn to a sort of “superposition,” or average of the possible sounds, Shaw said. Ultimately, this superposition contributes to how languages change over time, he added.

Shaw said he hopes to further explore this contribution, noting that it has implications for the entire field of linguistics, from historical linguistics and linguistic variation to the interplay between syntax and phonemic formulation.

Japanese is a member of the isolated Japonic family of languages, related only to the languages spoken on nearby Ryukyuan islands.

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