# The stuff of thought is the stuff of experience, says a new study

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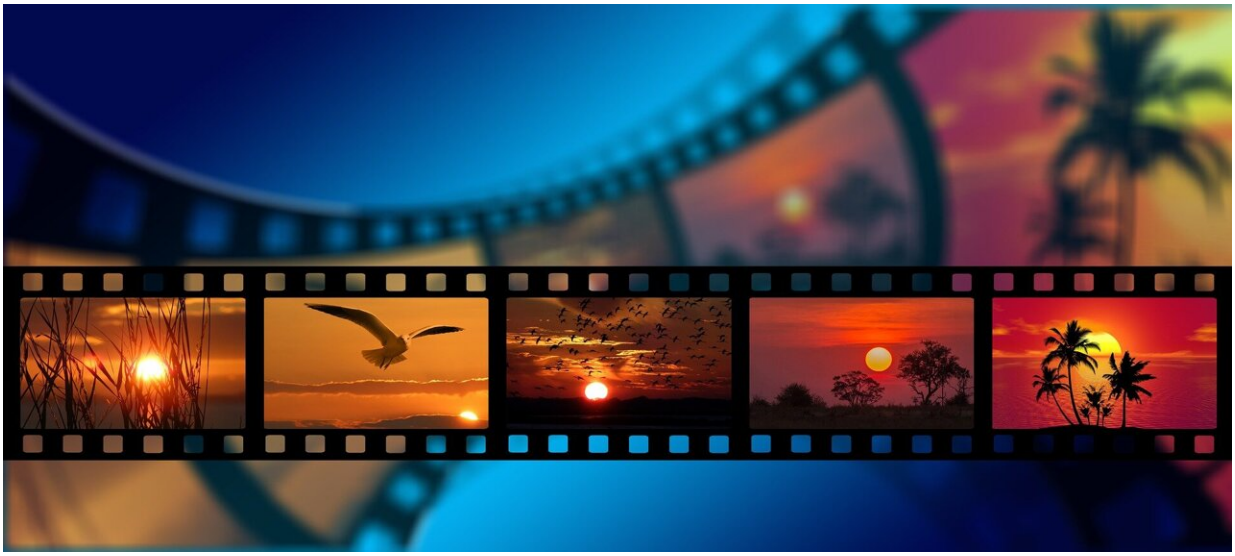

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A new study by researchers at the Medical College of Wisconsin (MCW) untangles the mystery of how we know what we know, uncovering that conceptual knowledge is tied to perceptual and experiential information.

"Our study addresses the question of how our thoughts relate to the physical world that we experience through our senses," said Dr. Leonardo Fernandino, assistant professor of neurology and biomedical

engineering at MCW. "We worked to find out how much of each type of information, including categorical, word-associative, and sensory information, is encoded in neural representations of word concepts."

Using functional magnetic resonance imaging (fMRI), Dr. Fernandino and his team measured neural activity throughout the brain while participants read hundreds of different words presented on a screen. Each word produced a unique activation pattern in the participant's brain. By analyzing these neural activation patterns, the researchers were able to quantify the extent to which different types of information were used by the brain to represent word meaning. Specifically, they evaluated how much information related to natural categories, word associations, or sensory experience was involved in the brain's representation of word meaning.

The analysis was based on the degree of similarity between word meanings that should be expected according to each type of information.

"As an example, 'vodka' and 'nitroglycerin' are very similar according to how they appear to the senses, since both are clear, odorless liquids, but we think of them as belonging to very different categories—drinks and explosives, respectively," said Dr. Fernandino.

Computer modeling was used to predict the degree of similarity between word meanings according to each type of information, and these predictions were compared to the similarities between the neural activation patterns corresponding to each word meaning.

"What we found is that each of these types of information may appear to be encoded in the neural representation of word concepts when examined in isolation; however, when we took into account the way their similarity predictions overlap with each other, our data showed that experiential information was the only type that predicted the similarities

between activation patterns independently. The other types of information only predicted the similarities between neural activation patterns to the extent that their predictions matched the predictions of experiential models," said Dr. Fernandino.

This experimental confirmation that experiences and sensory information are key to conceptual knowledge is groundbreaking for a subject area that has been studied since the fifth century BCE.

"This has been the subject of a long-standing debate in philosophy and psychology that can be traced back to the Ancient Greek philosophers Plato and Aristotle," said Dr. Fernandino.

Plato argued that humans are born with innate ideas, which are mental templates for all sorts of things we can name or recognize. Aristotle argued that mental categories were not present from birth but were learned from experience.

Today, researchers are still split with respect to these perspectives. Some believe that conceptual categories are represented in the brain in "symbolic" form rather than from learned sensory experiences. As conceptual knowledge is further studied using modern advancements, the research from Dr. Fernandino and the team at MCW is key in providing concrete evidence otherwise.

**More information:** Leonardo Fernandino et al, Decoding the information structure underlying the neural representation of concepts, *Proceedings of the National Academy of Sciences* (2022). DOI: 10.1073/pnas.2108091119

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