

# Exploring how abstract concepts are represented in the brain across cultures, languages

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Researchers at Carnegie Mellon University have explored the regions of the brain where concrete and abstract concepts materialize. A new study now explores if people who grow up in different cultures and speak different languages form these concepts in the same regions of the brain.

"We wanted to look across languages to see if our cultural backgrounds influence how we understand, how we perceive [abstract ideas](#) like justice," said Roberto Vargas, a doctoral candidate in psychology at the Dietrich College of Humanities and Social Sciences and lead author on the study.

Vargas is continuing [fundamental research](#) in neural and semantic organization initiated by Marcel Just, the D.O. Hebb University Professor of Psychology. Just began this process more than 30 years ago by scanning the brains of participants using a [functional magnetic resonance](#) imaging (fMRI) machine. His research team began by identifying the regions of the [brain](#) that light up for concrete objects, like an apple, and later moved to [abstract concepts](#) from physics like force and gravity.

The latest study took the evaluation of abstract concepts one step further by exploring the regions of the brain that fire for abstract objects based on [language](#). In this case, the researchers studied people whose [first language](#) is Mandarin or English.

"The lab's research is progress to study universalities of not only single concept representations, but also representations of larger bodies of knowledge such as scientific and technical knowledge," Just said. "Cultures and languages can give us a particular perspective of the world, but our mental filing cabinets are all very similar."

According to Vargas, there is a fairly generalizable set of hardware, or network of brain regions, that people leverage when thinking about

abstract information, but how people use these tools varies depending on culture and the meaning of the word.

This was one of the first studies to examine the degree of commonality in the [neural basis](#) for representing abstract concepts across languages while providing a framework for identifying language-specific differences in the meaning of individual abstract concepts.

During the study, Vargas and Just gathered brain scans from 20 participants, with equal representation from those who speak English and Mandarin. Participants were given 28 individual abstract concepts that spanned seven categories: social, emotion, metaphysics, law, religiosity, mathematics and scientific. While in the fMRI machine, participants would think about a prompt from one of these categories, like sacrilege in the religiosity category, for three seconds. Between each prompt, the participant would clear their mind by staring at a shrinking, blue ellipse for seven seconds. The series was repeated six times to provide multiple datasets for statistical analyses and to train and test models.

The study shows that a common neural infrastructure does exist between languages. While the underlying neural regions are similar, how the areas light up is more specific to each individual.

"I think the more that I conduct this line of research the more I realize that humans are not so unique with how they think about things," Vargas said. "We evolved with similar brains that perform specific functions. It is like muscles in the body. If you are in an occupation that involves [social interaction](#), the part of your brain that processes social information will be activated more and connect more diversely across the brain."

The similarity for the math-focused concepts may lie in the high cross-language similarity of math and science. The similarity in emotion and

social concepts may lie in the common circumstances and relationships behind these concepts.

"These findings speak to the universal way that brains from all cultures deal with abstract information," Just said. "Despite each culture developing its own somewhat differing conceptions of the world, all brains organize the abstract concepts the same way, using the same brain systems."

This study, as well as previous work completed by Vargas and Just, was based on samples of less than 20 participants each. Vargas hesitates to make any larger sweeping statements about how this work applies in a larger cultural context due to the small sample size and comparison of only two languages. He wants to continue this work but take it in a new direction, specifically focusing on how abstract concepts manifest in a sociological or cultural context.

"Now that I have a sense of how abstract concepts are generalizable across individuals, I can start asking wild questions about abstract concepts in the context of our social world," Vargas said.

Vargas will continue this work through two projects. One will examine how social identity affects decisions on reward and punishment. The second examines the way people think about concepts related of our societal environment, such as police and healthcare, and how these concepts differ across racial groups.

The research was published in *Human Brain Mapping*.

**More information:** Robert Vargas et al, Similarities and differences in the neural representations of abstract concepts across English and Mandarin, *Human Brain Mapping* (2022). [DOI: 10.1002/hbm.25844](https://doi.org/10.1002/hbm.25844)

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