

# The Origin of One

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It is an ability we take for granted every day. We see one apple, we think one apple. We see a dozen roses, we think 12 roses. We dream of an ice cream cone piled high with each of the 31 flavors. It is easy to assume that our ability to conceptualize numbers is a basic part of being human, an ability we are born with.

For APS Fellow Susan Carey, Harvard University, however, the human capacity to represent natural numbers is a cultural construction, and not completely of an evolutionary origin. It is this human ability to extend the limits of core knowledge that Carey explored in her William James Fellow Award Address “The Origin of Concepts.”

“The human capacity to represent numbers is built on several systems of core knowledge, each of which lacks the power to represent natural numbers,” Carey said. “The integer list representation of natural numbers is a cultural construction that transcends these core systems.”

Carey identified three distinct systems from evolutionary heritage that deal with numeric content: object representation, analog magnitude representation, and natural language quantifiers. These core knowledge systems, however, lack the power to represent natural numbers.

“None of the core knowledge systems has the power to represent actual integers,” Carey said. “You cannot represent ‘15’ in any of them.”

Infants can perceive the difference between one and two, and two and three, Carey said. They can compute same versus different, more versus less, and plus and minus one. Babies can also perceive one versus two and two versus three, but at three versus four, they begin to have trouble. While they can represent numbers, they are unable to represent the natural numbers or subsets of the natural numbers.

Toddlers also know what “one” means. If asked for one object, they are able to give you one object. If asked for any other number of objects, however, they pick up a number unrelated to the amount requested. Until they master the counting list of numbers, they are unable to move beyond three objects. Once children know the number list, they begin to use bootstrapping mechanisms to create representations of the natural numbers.

Bootstrapping is a mechanism by which cultures and acculturated individuals construct systems that go beyond core knowledge. Number words are learned directly as quantifiers, serving as placeholders for an external symbol system representing the natural numbers. These symbols are directly interpreted, bypassing the core knowledge systems inherited from our evolutionary past.

The human capacity to represent the natural numbers is derived from several core knowledge systems of our primate heritage, and from the human language and bootstrapping capabilities of our human

evolution. The list of counting numbers is a cultural construction that transcends core knowledge, allowing us to conceptualize the one apple, the 12 roses, the 31 flavors at the corner ice cream shop, and to realize that two hands is probably not enough to carry them all.

Carey delivered her William James Fellow Award Address at the APS Annual Convention in Atlanta. The award is given to psychological scientists for their lifetime of significant intellectual contributions to the basic science of psychology.

*Editor's Note: Coverage of William James and James McKeen Cattell Fellow Award addresses at the 15th APS Annual Convention appeared in the August and September Observers. Coverage will conclude with Anne Treisman in November.*