

# Ensemble Physics: Perceiving the Mass of Groups of Objects is More Than the Sum of Its Parts

**Vicente Vivanco**

MIT, Cambridge, Massachusetts, United States

**Joshua Tenenbaum**

MIT, Cambridge, Massachusetts, United States

**Vivian Paulun**

Massachusetts Institute of Technology, Cambridge, Massachusetts, United States

**Kevin Smith**

Massachusetts Institute of Technology, Cambridge, Massachusetts, United States

## Abstract

Imagine pouring a box of granola into a bowl. Are you considering hundreds of individual chunks or the motion of the group as a whole? Human perceptual limits suggest we cannot be representing the individuals, implying we simulate ensembles of objects. If true, we would need to represent group physical properties beyond individual aggregates, similar to perceiving ensemble properties like color, size, or facial expression. Here we investigate whether people do hold ensemble representations of mass, using tasks in which participants watch a video of a single marble or set of marbles falling onto an elastic cloth and judge the individual or average mass. We find first that people better judge average masses than individual masses, then find evidence that the better ensemble judgments are not just due to aggregating information from individual marbles. Together, this supports the concept of ensemble perception in intuitive physics, extending our understanding of how people represent and simulate sets of objects.