Trends in
Cognitive Sciences

CellPress

Spotlight

A world of things and stuff

Susan Hespos [1,2,*], Antonia Götz [1,2], and Tijl Grootswagers [1,2]

It appears simple that every entity in our perceptual array is a thing (object) or stuff (substance). Yet, a recent article by Paulun and colleagues reveals that there are many puzzles to be solved about how we perform this seemingly simple perception.

In his writings on physics from the 4th century BCE, Aristotle observed, 'We say that the nature of a thing is its form rather than its matter' [1]. This still rings true: we make intuitive inferences about the physical world frequently, rapidly, and effortlessly [2]. One common example is the distinction between things and stuff. Things are coherent entities; they tend to hold a constant shape. Things can be picked up, stacked to form towers, or thrown. However, the world is not made of things alone. Liquids, powders, and gels are examples of stuff (or, in Aristotle's terms, 'matter'). Stuff can swirl, drip, or be sticky. We use things and stuff every day, yet history and research have focused primarily on things, not stuff. Happily, a recent article in *Current Biology* finally puts stuff in the spotlight [3].

In their recent paper, Paulun and colleagues used fMRI to measure brain activity in adults as they watched captivating videos of things and stuff. The main question was: could the difference between things and stuff serve as an organizing principle of visual processing? More specifically, do objects and substances activate different cortical subregions in the dorsal and ventral visual pathways? To address these questions, adults watched videos depicting two types of object (rigid and squishy) and two types of substance (liquid and granular) (Figure 1). The scenarios varied across three types of event: things or stuff going down stairs, hitting an obstacle, or tilting back and forth inside a transparent container.

The main findings revealed that both lateral occipital cortex (LOC) and frontoparietal 'physics network' (FPN) were activated by both types of stimulus, but crucially, there were functional dissociations for things and stuff. This study provides the first neural evidence linking the perception of substances to a specific subregion. These substance-activated areas were different from subregions activated for objects, regardless of motion type; that is, whether they were traversing stairs, hitting obstacles, or moving inside a container. Importantly, there were no differences in activity between objects that were rigid or squishy, or between substances that were liquid or granular. An interesting avenue for future work would be to explore whether such differences might be evident in more subtle multivariate patterns of activation (e.g., [4]).

There is converging evidence for a distinction between things and stuff from a variety of disciplines. Paulun *et al.*'s work is the first to provide evidence from neuroscience. These findings corroborate behavioral studies on infants. Five-month-old infants have expectations that liquids pour and sand accumulates [5]. In situations where concepts develop through experience, but without instruction or deliberate reflection, development tends to enrich conceptual abilities, not change them fundamentally. Thus, studying the origins of an ability can provide insight into the mature ability [6]. Taken together, these studies support the idea that, similar to objects, there might be continuity in how substances are represented through development.

Research in linguistics reveals a nuanced interplay between how things and stuff are formalized in grammar [7,8]. All languages express both count and mass meanings at a lexical level. For example, in English, nouns for objects can take plurals, such as cup*s*, and quantifiers, such as five pens. There are mass nouns for substances, for example mud and gold, that rarely take plural forms (mud*s*) or numeric quantifiers (*a* gold). This linguistic evidence aligns with the distinction between objects and substances described by Paulun *et al.* as well as the developmental work. The nuance revealed in the linguistic work is that, while all languages make an object/substance distinction, there is variability across languages in how the syntax is triggered by count and mass meanings.

Knowing that the distinction between things and stuff is evident in higher visual areas, such a LOC and FPN, but not in primary visual cortex, could have implications for how computational models represent objects and substances. This is important because the next generation of artificial intelligence (AI) might benefit from understanding the processing differences in modeling how to represent objects differently from substances. As Paulun *et al.* note in their discussion, physics engines tend to represent things as a mesh and substances as particulates. Future research could investigate whether a 'physics engine' or a things-versus-stuff dimension emerges naturally in the embeddings learned by image or video AI models.

Studying the interplay between things and stuff could lead to new insights that move us closer to solving the remaining puzzles concerning how we make intuitive inferences about the physical world. One unique aspect of the recent paper by Paulun and colleagues is that the reported difference in activation occurs within cortical regions. Previous work using this paradigm found different activation patterns

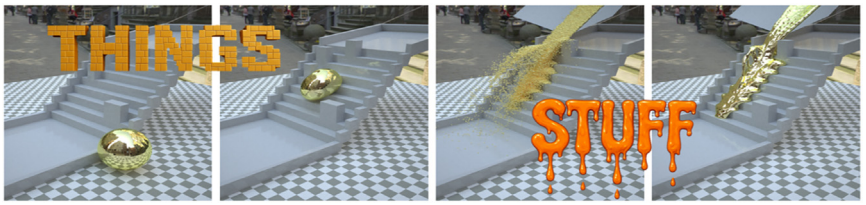

Figure 1. Examples of things (objects) and stuff (substances). Illustrative stimuli contrasting objects ('things') and substances ('stuff') as used by Paulun *et al.* [3]. (A) Things, such as rigid and deformable solids, maintain their shape and move as coherent bodies. (B) Stuff, such as liquids and granular materials, flows or disperses without a fixed form. Video stills courtesy of Vivian Paulun.

across cortical regions (e.g., faces and the fusiform face area or places and the parahippocampal place area). The results of Paulun *et al.* are novel in that both object and stuff activation occur within LOC and FPN. Perhaps Aristotle was right that the nature of the relationship between objects and substances might be more flexible than other organizing principles, such as faces and places.

Acknowledgments

S.H. was supported by Australian Research Council grant DP250101325. T.G. was supported by Australian Research Council grant DE230100380.

Declaration of interests

None declared by authors.

[1]MARCS Institute for Brain, Behaviour, and Development, Western Sydney University, Westmead, NSW 2145, Australia
[2]www.westernsydney.edu.au/babylab

*Correspondence:
s.hespos@westernsydney.edu.au (S. Hespos).

https://doi.org/10.1016/j.tics.2025.09.019

References

1. Aristotle (1998) *Metaphysics*, Penguin Classics
2. Kanwisher, N. (2025) Animal models of the human brain: successes, limitations, and alternatives. *Curr. Opin. Neurobiol.* 90, 102969
3. Paulun, V.C. *et al.* (2025) Dissociable cortical regions represent things and stuff in the human brain. *Curr. Biol.* 35, 4075–4083
4. Robinson, A.K. *et al.* (2023) Visual representations: insights from neural decoding. *Annu. Rev. Vis. Sci.* 9, 313–335
5. Hespos, S.J. and Anderson, E.M. (2020) Infant physical knowledge. In *Cambridge Handbook of Infant Development: Brain, Behavior, and Cultural Context* (Lockman, J.J. and Tamis-LeMonda, C.S., eds), pp. 363–380, Cambridge University Press
6. Spelke, E.S. (2022) *What Babies Know: Core Knowledge and Composition*, Oxford University Press
7. Rips, L.J. and Hespos, S.J. (2019) Concepts of objects and substances in language. *Psychon. Bull. Rev.* 26, 1238–1256
8. Doetjes, J. (2021) Count-mass asymmetries: the importance of being count. In *Things and Stuff: The Semantics of the Count-Mass Distinction* (Kiss, T. *et al.*, eds), pp. 81–114, Cambridge University Press