# From fluffy to valuable: How the brain recognises objects

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Credit: AI-generated image (disclaimer)

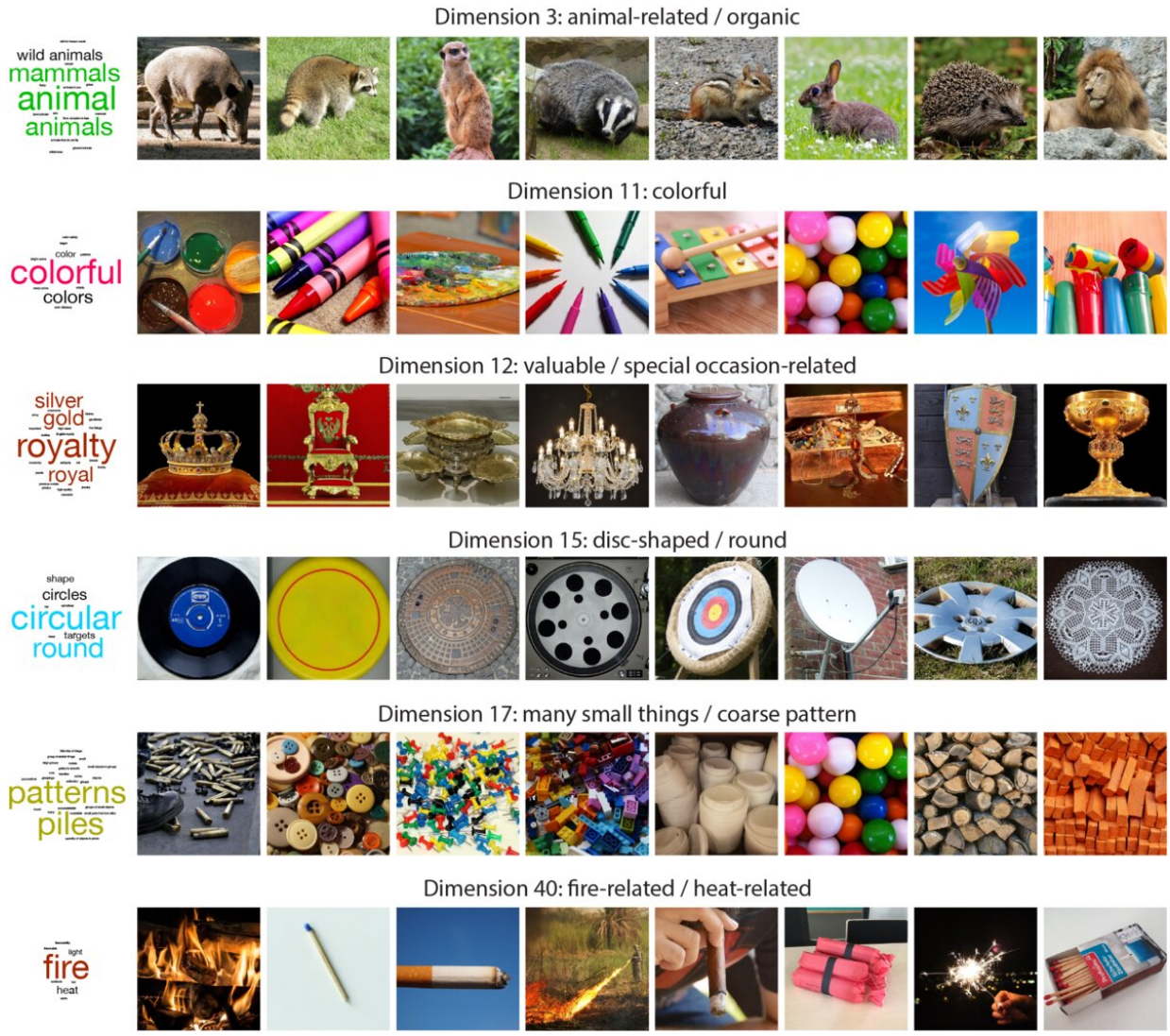
To recognize a chair or a dog, our brain separates objects into their individual properties and then puts them back together. Until recently, it has remained unclear what these properties are. Scientists at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig have now identified them—from "fluffy" to "valuable"—and found that

all it takes is 49 properties to recognize almost any object.

We live in a world full of things that we have to identify and classify into different categories. Only when you are able to identify the things around you, you can communicate with others about them and act in a meaningful way. If we see something in front of us that we recognize as a chair, we can sit on it. Once we have identified an object as a cup, we can lift it up and drink from it.

In order to carry out this mapping and make sense of our environment, we have to constantly compare the input to our senses with the information we have already learned. To do this, the brain breaks down an object into its individual properties, compares them with those that are already known, and puts these properties back together. Depending on how similar the observed object is to a known category, it is then recognized as a piece of furniture or a vessel. So far, however, it has remained unclear how we consider things to be similar or less similar. In other words, what are the characteristics that make us recognize objects?

Scientists at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, in collaboration with the National Institute of Mental Health in Bethesda, U.S., have now identified a set of 49 properties that allow us to determine almost all objects, i.e. the properties underlying their so-called mental representation. This representation reflects the format into which the brain translates a stimulus. In the case of an object, it is composed of, for example, color, shape and size, but perhaps also of the fact that it 'is natural,' 'can move,' 'is valuable' or 'is animal-related.' The researchers had been looking for the set of dimensions that were interpretable and minimally sufficient, i.e. that contained as few properties as possible and yet were enough to describe everything.

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"Our results show that it actually takes surprisingly few dimensions to characterize all objects in our environment," says Martin Hebart, first

author of the article describing these results. The human brain breaks down the environment into a total of 49 properties, which are sufficient to categorize all objects. "From these dimensions, we can also infer what is perceived as particularly similar or what is perceived as particularly typical for a category," the neuroscientist continues. Whether, for example, a mussel or a dog is perceived as a more typical animal. "Fundamentally, this explains the basic principles of our thinking about objects."

However, the results could also be used for medical purposes. Until now, it was believed that patients who cannot identify certain animals because of brain damage would not be able to recognize animals as a whole. But it is possible that the patient has a deficit in recognizing the characteristic "fluffy" that is a property of many animals. This may then lead to other forms of therapy.

The scientists investigated these relationships with the help of almost 2,000 pictures of objects representative of most things encountered in our environment. They then showed study participants three of the pictures at a time, for example, koala, dog and fish, but also koala, doormat and pretzel. From each of these, the participants were asked to choose the 'odd one out,' the one that they perceived to be most different from the other two. In the case of koala, doormat, and pretzel, for some this might have been the koala, because, unlike the other two, it is a living creature or is considered 'not flat.' For others, it might have been the pretzel, because doormats and koalas are fluffy or you can only eat the pretzel. Yet for others, it might be the doormat, because it is made of inorganic material. This means that the answers are not always clear, but they highlight the relevant properties to find out all the core dimensions of objects.

The researchers tested almost 1.5 million combinations of three objects with the help of nearly 5,500 participants. From this, they developed a

computational model which they used to calculate which object was most likely to be chosen to be the odd one out. The more often two objects are left in, the more similar they are. It turned out that their model enabled the scientists to predict the similarity of two objects very precisely. But it also provided the 49 core dimensions that enable us to categorize our world according to simple criteria.

**More information:** Martin N. Hebart et al. Revealing the multidimensional mental representations of natural objects underlying human similarity judgements, *Nature Human Behaviour* (2020). DOI: 10.1038/s41562-020-00951-3

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