

Basic-level categories: formation and constitution

Andreas van Cranenburgh*

December 9, 2007

Abstract

The nature of concepts has been debated since the dawn of philosophy. For some time now cognitive psychology also contributes to this discussion. This paper reviews some research in this area to argue that categories can be formed by perceptions and that concepts are embodied; embedded in the sensory-motor system.

“This paper is based upon the theory already established, that the function of conceptions is to reduce the manifold of sensuous impressions to unity, and that the validity of a conception consists in the impossibility of reducing the content of consciousness to unity without the introduction of it.”

(*On a new list of categories*, Charles S. Peirce, 1868)

1 Introduction

1.1 Different takes on concepts

Starting with Aristotle’s seminal work *On categories* categories are traditionally defined by *necessary and sufficient* conditions. However, this strict order seems, more often than not, elusive, if not absent, in the real world. On the contrary, categories can appear to represent a continuum (eg. colors); or lack defining features (eg. ‘game’ according to Wittgenstein) which leads to fuzziness.

An alternative is the prototype theory, more or less explicitly adhered to by both Eimas[2] and Mareschal[6]. It states that for each category, there is a prototypical exemplar. Classification occurs by measuring the differences in features with this exemplar. This

can explain the effect of gradual ‘membership.’

Finally, to argue that categories are not as abstract and symbolic as traditional accounts would have it, I will summarize the results of Gallese and Lakoff[4].

1.2 Basic-level categories

An important notion in both Eimas[2] and Mareschal[6] is that of *basic-level categories*. These categories represent the most natural level; neither too general nor too specific. For example one is inclined to call this article simply an ‘essay,’ but not ‘some text’ nor a ‘cognitive psychology essay’; another example is furniture/chair/rocking chair.

Categories that are too general are more vague and difficult to conceive (how would one draw a picture of ‘mammal’?), and conversely categories that are too spe-

*andreas@unstable.nl

cific are cumbersome and tedious (the specific family a cat belongs to is not relevant most of the time).

2 Infant categorization

2.1 Perceptually based categories

One form of research into category forming of infants studies visual attention. Different photos are presented in both familiarization and test trials. The amount of time infants look intently at the photos determines how ‘novel’ its content is. It is assumed that items from familiar categories will not appear novel, and items from new categories will be met with more interest by the subjects.

In order to make the hypothesis of category forming plausible, it must be shown that preferential attention is not simply given to any ‘novel’ item, but significantly more to novel *categories*. As Eimas et al[2] have shown. Infants, 3 to 4 months of age, were significantly more interested in novel lions than in novel cats, after being familiarized with cats – thus demonstrating exclusivity in categories.

The mechanism of category forming they envision is based on sorting exemplars according to their features. As a result, greater variation in features makes it more difficult to form categories.

From their research it appears that fine distinctions can be made by young children, *given appropriate experience*. Specifically, novel lions were perceived not to be part of the cat category, yet did not already seem to form a category on its own, due to lack of sufficient familiarization with lions. Thus it appears that categorical distinction need not be innate, but conversely is inferred in bottom-up fashion from perceptual input.

2.2 Object examination tasks

In object examination tasks subjects handle concrete examples of the concepts in question. It has been a point of debate that the perceptual task in preferential looking methods does not amount to actual concept learning, since it is only on a perceptual level (perhaps only conditioning occurs). However it has been shown by Mareschal et al[6] that basic-level category learning also occurs in object examination experiments with infants.

The recipe is to collect toy figures of the concepts to be studied, and then present them to the subjects. They should be able to touch and examine them, all the while observed by the experimenters, noting how much attention each toy figure receives. Afterwards these examination times can be analyzed to discover whether habituation occurred, which signifies that categories were formed.

The specific features of each toy figure can also be measured, in order to compare the effect of the feature distributions on category formation. It is interesting to see how these preconditions interact with the actual end result.

In Mareschal[6] it turned out that much depends on the variability of the stimulus. Specifically, if the category of cats was presented first, both dogs and eagles were excluded; yet, if the category of dogs was learnt first, it actually included cats, but excluded eagles. This result suggests that since the category of dogs is broader, in terms of variability, it was more difficult to demarcate. Also, it was found that the category of cats depend mostly on body features (total length and height, form) and less on facial or head features. The category of dogs, on the other hand, depended mostly on facial features,

but less on body or head features.

3 Concepts are embodied

In Gallese and Lakoff[4], it is argued that concepts are part of our sensory-motor system. That is, concepts depend wholly on our perception and the way they can be handled. Consider the category of chairs; would it exist without humans to sit on them?

It is not that categories are merely functionally defined¹ – one might more comfortably sit on a rock than on a broken chair; still the broken chair is more of a chair than the rock. It is our way of seeing and sitting that *calls the category of chair into being*. This point of view is supported by the findings that perceiving and imagining activates the same brain structures (cf. canonical and mirror neurons, Gallese and Lakoff[4]); the same goes for mental imagery (Farah[3]).

This position obviates the idea of abstract, symbolic representations of concepts; according to the article Occam’s razor should be applied since otherwise concepts would need to be present both inside and outside the sensory-motor system. The purported ‘association areas’ are not necessary to integrate different modalities since the different brain structures are already multimodal. The multimodal point of view denies the existence of strictly separate brain modules.

References

- [1] Hubert L. Dreyfus, *What computers still can’t do: A critique of artificial reason*, Cambridge, Massachusetts : MIT Press (1992)

¹See Roberts[7], which shows that prelinguistic categories can be based on form alone

4 Further considerations

Many more articles treat the subject of categories and concepts. There is an interesting contrast to make between the prelinguistic and linguistic stages, as concepts can become more complex in the latter – which implies the addition of metaphors, according to Lakoff and Johnson[5].

Arguably, the idea of embodiment traces back to the philosophy of Heidegger in *Being and Time*. Also, it is worth noting that Hubert Dreyfus has applied this philosophy to argue that traditional artificial intelligence relies on unwarranted assumptions[1] – among them, that the role of the body can be neglected.

5 Conclusion

Two arguments now come together. First, it has been shown that perceptual data influences category formation. Second, a theory has been presented which claims these categories are based on such perceptual data alone, combined with motor schemas.

This is in stark contrast with traditional dualist assumptions; even though not based on scientific foundations, such ideas continue to influence research agendas; be it for religious, philosophical or simply historical reasons (e.g. the separation between biology and psychology).

- [2] Peter D. Eimas, Pail C. Quinn and Pamela Cowan, *Development of Exclusivity in Perceptually Based Categories of Young Infants*, Journal of Experimental Child Psychology, 58, p. 418-431 (1994).
- [3] M.J. Farah, *The neural bases of mental imagery*, In 'The cognitive neurosciences', 2nd ed. (2000).
- [4] Vittorio Gallese and George Lakoff, *The brain's concepts: The role of the sensory-motor system in conceptual knowledge*, Cognitive Neuropsychology, 22, p. 455-479 (2005)
- [5] Lakoff, G. & M. Johnson, *Philosophy In The Flesh: The Embodied Mind and Its Challenge to Western Thought*, Basic Books (1999).
- [6] Denis Mareschal, Daisy Powell and Agnes Volein, *Basic-level category discriminations by 7- and 9-months-old in an object examination task*, Journal of Experimental Child Psychology, 86, p. 87-107 (2002).
- [7] Kenneth Roberts, *Retrieval of a basic-level category in prelinguistic infants*, Developmental Psychology, 24, p. 21-27 (1988)