Edouard Machery

Abstract Word Count: 65
Main Text Word Count: 1176
References Word Count: 109
Total Word Count: 1363

Are Prototypes and Exemplars Used in Distinct Cognitive Processes?

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Abstract: We argue that Machery provides no convincing evidence that prototypes and exemplars are typically used in distinct cognitive processes. This partially undermines the fourth tenet of the Heterogeneity Hypothesis and thus casts doubts on Machery's way of splitting concepts into different kinds. Although Machery may be right that concepts split into different kinds, such kinds may be different from those countenanced by the Heterogeneity Hypothesis.

Machery's argument that concepts split into different kinds is bold and inspiring but not fully persuasive. We will focus on the lack of evidence for the fourth tenet of Machery's

Heterogeneity Hypothesis (HH), according to which "prototypes, exemplars, and theories are typically used in distinct cognitive processes" (Machery, 2009, p. 4).

Machery lists three types of evidence that may support his fourth tenet. If any of the following is shown for two kinds of concept, then, likely, the two kinds of concept are used in distinct cognitive processes (Machery, 2009, p. 124):

1. The neural systems implementing the cognitive processes that use the two kinds of concept are doubly dissociable.
2. The cognitive processes that use the two kinds of concept exhibit a difference in their input-output functions.
3. The cognitive processes that use the two kinds of concept do so by means of different algorithms.

We accept these three criteria with one exception pertaining to Criterion 2: while we agree that a difference in outputs is evidence of distinct processes, we deny that a difference in the inputs alone is good evidence of distinct processes.

Machery maintains that an input difference in categorization, e.g., categorizing some items by means of prototypes and other items by means of exemplars, is evidence enough for his fourth tenet (Machery, 2009, p. 124). Assuming for the sake of the argument that some items are indeed categorized by means of prototypes and others by means of exemplars, this shows only that we possess both prototypes and exemplars and use both in categorizing. Given this evidence, it may be that prototypes and exemplars are used in *distinct* processes, but it may also be that both prototypes and exemplars are used in the *same* process. Neither possibility is

favored by an input difference. With this caveat in place, we will argue that Machery does not fulfill any of his three criteria with respect to prototypes and exemplars. Some of our considerations will go even further and raise doubts about Machery's splitting of concepts into prototypes, exemplars, and theories.

As to Criterion 1, Machery presents no evidence of doubly dissociable neural systems involving prototypes and exemplars. The only evidence he describes is of a *single* dissociation in amnesic patient E.P. (Machery, 2009, p. 214). Since E.P. could not recognize previously seen items, E.P. may be unable to add new exemplars to his long-term memory. But E.P. could still correctly categorize simple dot patterns in a way that suggests he used prototypes (Machery, 2009, p. 215).

After citing E.P.'s case, however, Machery cites evidence that previous exposure to category members is not necessary to perform well in the dot pattern task used to test E.P. A similar performance may be obtained by relying solely on short-term memory (Palmeri & Flanery, 1999). Thus, as Machery points out (2009, p. 217), E.P.'s performance does not show that E.P. categorized by means of prototypes in the absence of exemplars (a single dissociation). And even if that were shown, a double dissociation would also require an additional case in which exemplars are used without prototypes.

As to Criterion 2, Machery's best evidence comes from experiments in which subjects learn some new categories A and B and then categorize some new stimuli as either A or B (Malt, 1989). Under some conditions, subjects appeared to categorize a new stimulus by comparing it to the old stimulus most closely resembling it. Malt interpreted this as exemplar-based

categorization. Under other conditions, subjects appeared to categorize a new stimulus by determining which features it possessed among those that were typical of a category. Malt interpreted this as prototype-based categorization. Based on Malt's experiments, Machery concludes that people categorize some items using prototypes and others using exemplars, and he implies that the processes involved are distinct (Machery, 2009, pp. 180-182). We reject Machery's conclusion for two reasons.

First, as we pointed out earlier, input differences alone are not good evidence of distinct processes. Thus, experiments such as Malt's do not support the fourth tenet of HH unless there are also output differences. Malt reports no output differences. She does report a priming effect that occurs only under the allegedly exemplar-based strategy. But the priming effect changes a subject's response time, not the output.

Second, Malt's experiments do not even show that, at least in the wild, subjects store both prototypes and exemplars properly so called (i.e., representations of particular objects) and use both in categorization. The stimuli in experiments 1-3 were drawings of real animals from different species (Malt, 1989, Figure 1). They depict what a typical member of a species looks like, without any features that would distinguish one particular animal from another. Such stimuli are too generic to provide convincing evidence that subjects store exemplars properly so called. By contrast, the stimuli in experiments 4-6 were artificial categories (Malt 1989, Figures 2 and 3) whose structure is too different from natural categories to warrant any firm conclusion about the ordinary process of categorization. Machery himself worries that "these experiments

tap into ad hoc strategies only used by subjects to deal with abnormal learning and categorization conditions" (Machery, 2009, p. 183).

As to Criterion 3, Machery points out that while both prototype-based models and exemplar-based models postulate that categorization involves a computation of similarity, the two classes of models are different in one respect. Prototype-based models usually employ a *linear* similarity measure, while exemplar-based models usually employ a *nonlinear* similarity measure. This may suggest that prototypes are processed following an algorithm that uses a *linear* similarity measure, while exemplars are processed following an algorithm that uses a *nonlinear* similarity measure.

But as Machery also points out, linear measures of similarity are not required for prototype-based models (2009, p. 90), and non-linear measures of similarity are not required for exemplar-based models (2009, p. 98). Thus, the use of linear- vs. non-linear measures does not determine whether an algorithm is prototype-based or exemplar-based. Therefore, there is no clear evidence that prototypes and exemplars are used in processes that follow different algorithms.

In conclusion, Machery has provided no convincing evidence that prototypes and exemplars are typically used in distinct cognitive processes. This lack of evidence is enough to at least partly undermine the fourth tenet of HH. The considerations we presented are part of a larger set of doubts on Machery's way of splitting concepts into prototypes, exemplars, and theories. Machery may yet be right that there are different kinds of concept, but there might be a more fruitful way to split concepts into kinds than that postulated by HH.

Specifically, one of us has argued that the two main kinds of concept are implicit concepts and explicit concepts. Implicit concepts encode information about a category in an implicit form that cannot be accessed directly by the language faculty, whereas explicit concepts encode information in an explicit form that can be manipulated by the language faculty (Piccinini, forthcoming, Piccinini & Scott, 2006). This proposal fits with and may contribute to explain a wide range of evidence about implicit versus explicit cognition (Evans & Frankish, 2009).

Acknowledgments

Thanks to Edouard Machery and Andrea Scarantino for helpful comments.

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