Special Issue: Against stored abstractions: A radical exemplar model of language acquisition

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What does a radical exemplar view not predict? A commentary on Ambridge (2020)

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Abstract
This article reviews two aspects of human learning: (1) people draw inferences that appear to rely on hierarchical conceptual representations; (2) some categories are much easier to learn than others given the same number of exemplars, and some categories remain difficult despite extensive training. Both of these results are difficult to reconcile with a learning and categorization system that operates only on specific exemplars. More generally, the article argues that specifying the empirical phenomena that a radical exemplar does not predict would aid in clarifying the radical exemplar proposal.

Keywords
categories, category learning, exemplar models, hierarchical structure, induction

In Borges' *Funes the Memorious* (1944/2007), the story's namesake has perfect memory. Funes is able to recall, with minute detail, all aspects of his experience, yet has trouble understanding even basic generic terms such as *dog*. 'To think,' concludes the narrator, 'is to forget differences, generalize, make abstractions' (p. 66). Could someone who stored only exemplars truly think? Ambridge (2019) does not deny that people *can* abstract (via a process of 'analogizing'), but on his view all abstracting happens 'on the fly' during comprehension and production.

We share Ambridge's enthusiasm for the importance of exemplars in language learning and agree that researchers often invoke abstract rules to explain behaviors that can be

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alternatively explained by relying on specific instances. One of our favorite examples is that when a novel verb, 'to frink,' is presented in the context of eye movements, people derive the past tense 'frinked'; when it is instead presented in the context of ingesting, the preferred past tense is 'frank' (Ramscar, 2002). Results of this kind, which are commonplace, are elegantly accounted for by the kind of analogy-driven processes favored by Ambridge. However, relying on exemplars alone makes it difficult to explain some behaviors that are well-attested yet not predicted by the radical exemplar view.

Hierarchical structure and category-based induction

The same object, event, relation – any entity, really – can be categorized at multiple levels. Is this a car, a vehicle, or a heavy thing? While the facility that people have with categorizing at different levels depends strongly on experience (Palmeri & Gauthier, 2004; Taylor & Tanaka, 1991), the relative ease with which people categorize at 'higher' (i.e., more abstract) levels presents a problem for the radical exemplar theorist. If on-the-fly analogies are required anytime we think of a car as a means of transport, then such superordinate categorization (and the inferences that draw on such representations) should be far more effortful than representing something at a more specific (basic or subordinate) level, if only because the analogizing process would need to draw on many more exemplars to represent something at a superordinate level. However, superordinate categories (such as animal and vehicle) can be identified extremely rapidly ($<$ 200 ms; VanRullen & Thorpe, 2001).

The ability to represent something at multiple levels of abstraction also offers a straightforward account of category-based induction (Murphy, 2016). Children are more likely to ascribe a shared property (e.g., gills) to perceptually-dissimilar animals in the same biological category (e.g., sharks and tropical fish) than to perceptually-similar animals in different biological categories (e.g., sharks and dolphins; Gelman & Markman, 1986). Category-based induction is easy to explain if, during development, people learn to represent, e.g., different fish as the 'same kind of thing' based on shared properties – a form of abstraction. It is not clear to us how category-based induction is achieved through exemplars alone. Does each exemplar of fish come tagged with a 'fish' feature? What is the mechanism for such tagging? And wouldn't such features themselves constitute abstract representations?

Difficulty with learning some categories despite extensive exposure

People find some categories hard to learn even after seeing many exemplars. In general, exemplar models succeed at these categories, often over-predicting human accuracy. For example, McKinley and Nosofsky (1995) found that even after a week of training, half of their participants failed to learn categories that required integrating information across two stimulus features, while exemplar models had no such difficulty. Even some small categories (e.g., just 8 exemplars) are hard to learn despite extensive exposure (in some cases hundreds of training trials; e.g., Shepard et al., 1961). Crucially, which categories are most difficult to learn is well-predicted by factors that determine how easy it is to

represent the category rule, such as logical complexity (Feldman, 2000, 2003) or nameability (Zettersten & Lupyan, 2020). If successful category learning is just about experiencing the right exemplars, why would learning depend on the complexity or accessibility of the underlying rule?

Another example of difficult-to-learn categories can be found in adult learning of non-native phonemic categories. During infancy, sensitivity to phonemic distinctions of the ambient language(s) improves while sensitivity to other phonemic distinctions declines (perceptual narrowing; Werker & Hensch, 2015). For adults to learn some kinds of non-native phonemic categories, enormous amounts of training are required (e.g., Iverson et al., 2005). Under the radical exemplar theory, these findings are puzzling. If adults undergoing extensive training on non-native distinctions are storing exemplars veridically and new phonemes are subsequently encoded directly in relation to these stored exemplars via 'on-the-fly analogy,' why should phoneme discrimination tasks remain so persistently difficult? These effects can be readily explained if one posits that the perceptual space for phoneme representation has been heavily transformed (or 'warped') through extensive experience with native exemplars, forming stable representations that non-native phonemic features are difficult to map onto (Best, 1994; Iverson et al., 2003). This process is consistent with the notion of gradual cue weighting advanced in exemplar-based models discussed by Ambridge (e.g., Regier, 2005). However, the key point in our view is that – in the domain of phonemic perception in particular and in many other areas of language in general – the transformation of the representational space is highly stable and relatively insensitive to local training. These stable representations seem to us to be better described as learned abstractions rather than as flexible representations constructed 'on the fly' by analogy to similar exemplars.

What would falsify a radical exemplar theory?

It is possible that the radical exemplar view can accommodate the phenomena above. Indeed, a common observation about exemplar models is that they are *too* powerful (e.g., Barsalou, 1990). If one assumes that each encountered exemplar is faithfully stored, then ever more powerful retrieval mechanisms can be invoked to account for virtually any pattern of behavioral data. This makes it particularly important to spell out in more detail how the processes of analogy work in Ambridge's model and, in particular, what limits these processes place on categorization. What phenomena does a radical exemplar view *not* predict?

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