Illuminating reasoning and categorization

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Abstract: The proposal regarding rules and similarity is considered in terms of ability to provide insights regarding previous work on reasoning and categorization. For reasoning, the issue is the relation between this proposal and one-process as well as two-process accounts of deduction and induction. For categorization, the issue is how the proposal would simultaneously explain both similarity-to-rule and rule-to-similarity shifts.

We first pose a general question: Is this proposal empirical or heuristic in nature? Is the claim that rules and similarity depend on a single process with varying numbers of features meant to be the sort of thing that is experimentally testable? Our own reaction is that, at the present time, the proposal may be consistent with the evidence presented, but it is not clear that the evidence better supports this proposal than the alternative of separate processes for rules and similarity. Therefore, our view is that it is better to consider this proposal in terms of its potential heuristic value. Does this proposal lead to important insights regarding the nature of rules and similarity in various cognitive activities? By assuming that rules are like similarity with a small number of features, how does this help to illuminate reasoning and categorization?

Reasoning. In textbooks there is a distinction between deduction and induction, but it is still a matter of debate whether there are two kinds of reasoning. This proposal appears to suggest that there is single process of reasoning, encompassing both logic and similarity. There have been many previous one-process accounts of reasoning about both deductive and inductive problems (Chater & Oaksford 2000; Harman 1999; Heit 1998; Johnson-Laird 1994; Johnson-Laird et al. 1999; Osherson et al. 1990; Sloman 1993). For example, Johnson-Laird et al. (1999) applied an account of deduction to a range of inductive problems, and Osherson et al. proposed an account of induction that treats deductive problems as a special case. However, none of the previous one-process accounts are concerned with the issue of how many features are required for different reasoning problems. Therefore, it is not clear how this proposal leads to new insights about these accounts. Perhaps the main point of contact is that the proposal identifies judgments based on fewer features as being more certain – and the goal of deductive inference is to derive certain conclusions from a set of premises. But it is not clear whether the certainty associated with deductive validity is a consequence of using a small number of features.

Other researchers have emphasized a distinction between two kinds of reasoning (Evans & Over 1996; Sloman 1996; Stanovich 1999). In these two-process accounts there is a quick, associative or similarity-based system, and a deliberative, rule-based system. Although these two systems do not necessarily correspond directly to induction and deduction, it is plausible that induction would depend more on the first system whereas deduction would depend more on the second system. In addition, there is some brain imaging evidence for two anatomically separate systems of reasoning (Goelet al. 1997; Osherson et al. 1998; Parsons & Osherson 2001). It would be important to spell out how the proposal illuminates these arguments. For example, why would a quicker system involve the consideration of more features than a slower system? Some of the arguments for two systems have been based on individual differences, for example, there are correlations between IQ and logical-type reasoning. Why would higher IQs be associated with ability to deal with small numbers of features, as opposed to large numbers of features? Finally, how does the proposal help to explain the neuropsychological evidence?

Categorization. Likewise, in categorization research there have been many previous one- and two-process accounts. Again, we would question how Pothos's proposal helps to illuminate the debate about neuropsychological evidence for two systems of categorization (e.g., Ashby et al. 1998; Nosofsky & Johansen 2000; Smithet al. 1998).

In comparison to reasoning research, in categorization research there is greater consideration of the nature and number of features. Some work has shown that the types of features extracted from a given set of inputs will differ with the nature of the categorization task (Schynset al. 1998) and with background knowledge (Heit 1997; Wisniewski & Medin 1994). Hence, it is not trivial to state how many features are used as a basis for classification.

Nevertheless, there have been several important observations of how feature numbers vary systematically in categorization. The proposal suggests that with practice people select features that are predictive or relevant to their current goals and suppress attention to other features; hence, there would be a shift from similarity to rules. There are indeed findings that are consistent with this pattern. For example, Kruschke (1992) reported that adults showed greater selective attention with increased practice in learning novel categories. Likewise, for children, Smith (1989) characterized developmental changes in categorization as a shift from a comparison of multiple features to a few criterial features.

However, there are many cases where the opposite pattern holds. According to Johansen and Palmeri (2002), early stages of category learning by adults depend upon single features, and hence rules, whereas later stages would involve multiple features, and hence similarity. Lamberts (2000) characterized fast classification judgments as using a small number of features, with a greater number of features accumulating at longer response intervals. In category construction studies, where people are required to sort multidimensional stimuli into distinct groups, one-dimensional sorting is the usual result (Medin et al. 1987; Spalding & Murphy 1996). It is only when attention is drawn to the relations between multiple stimulus dimensions that family resemblance categories are constructed. In addition, Gentner and Medina (1998) have described developmental changes in categorization as a shift from the matching of individual features to comparisons based on higher-order relations involving many features.

To describe these patterns purely in terms of number of features (i.e., as a shift from similarity to rules in the first pattern, and from rules to similarity in the second) does not illuminate these findings very much. The important issue is not whether a few or many features are used for categorization, but rather, the processes involved, the kinds of features that are being processed, and the way that features are integrated or combined (see Markman & Ross 2003, for related arguments).

Conclusion. There are, no doubt, important relations between the cognitive activities of reasoning, categorization, learning, and language, and on that basis this ambitious proposal is welcomed. However, what remains to be illuminated is an explanation of why the number of features varies.

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