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MENTAL LEAPS: ANALOGY IN CREATIVE THOUGHT

by Keith J. Holyoak and Paul Thagard

Cambridge, MA: MIT Press, 1995. Pp. xiv + 320. ISBN 0-262-08233-0. US \$24.95.

Reviewed by David Hitchcock

Every informal logician who intends to write about analogies should read this book.

Keith Holyoak, a cognitive psychologist, and Paul Thagard, a philosopher, here advance a general theory of analogical thinking. They illustrate their theory with reference to the use of analogies in a wide variety of domains, including the thinking of animals and children, decision-making, philosophy, science, education, cultural practices, and psychotherapy. The index lists 120 analogies mentioned in the book.

According to Holyoak and Thagard, analogical thinking is governed by the multiple constraints of similarity, structure and purpose. Take a simple example of animal learning (p. 39): if a bird eats a noxious monarch butterfly, it will likely refrain in future from eating other monarch butterflies, as well as from eating viceroy butterflies, a species which looks like the monarch. But it will eat other kinds of butterflies which look less like the monarch. The bird's purpose here is to get acceptable meals. Having this goal, it avoids new butterflies which share certain perceptual similarities with the unacceptable monarch it tried to eat. The implicit comparison between the source (the monarch which tasted bad) and the target (a butterfly which looks like that monarch) involves a one-to-one matching between a set of characteristics of the source and a set of characteristics of the target. In this case, the structure matches the simplest kind of characteristics, immediately perceptible attributes.

Experiments on animals and children indicate that there is a hierarchy of increasing complexity and abstraction with respect to the characteristics compared in analogical thinking. A given species of animal or a child of a given age will be capable of analogical thinking up to a certain point in the hierarchy but not beyond it. At the lowest stage of the hierarchy are perceptible attributes such as colour. Next come such basic relations between perceptual attributes as relative brightness and relative size. Next come more abstract relations between attributes, such as being perceptually similar or being perceptually different; recognizing the similarity between a source which has two perceptually similar objects (e.g., two apples) and a target which has two perceptually similar objects (e.g., two hammers) requires thinking about the perceptual attributes of objects, as opposed to reacting to them. Finally come higher-order relations, such as relations between relations (e.g., being the same relation as, having the reverse effect of) and relations between propositions (e.g., causing); comparison of such relations involves what the authors call "system mapping".

Children become capable of attribute mapping by the age of 18 months, of relational mapping around age three, and of system mapping around age five. No other species has yet been trained to engage in system mapping.

Analogical thinking involves four successive stages: selection, mapping, evaluation, learning. All three constraints of similarity, structure and purpose operate at each stage, though their importance varies by stage. Analogical thinking begins with the selection of a source analogue to help the thinker accomplish some purpose with respect to a target; for example, in trying to decide how the United States should respond to Saddam Hussein's invasion of Kuwait, somebody might select as a source analogue Adolph Hitler's invasion of Austria. Selection of the source is guided largely by similarities (e.g., of Saddam to Hitler and of Kuwait to Austria) but also by structure (e.g., that the relation of Saddam to Kuwait in August 1990 is the same as that of Hitler to Austria in March 1938). Having selected a source, the thinker then maps components of the source to components of the target; for example, Hitler might be mapped to Saddam, Austria to Kuwait, France to Saudi Arabia, Britain to the United States, Churchill to George Bush. Mapping is predominantly controlled by constraints of structure, and can generate similarities which are not present independently of the mapping. The mapping chosen will generate inferences about the target, for example, that a military intervention by the United States will force Iraq to leave Kuwait. But any such inference needs to be evaluated: "Analogies should enhance thinking, not substitute for it" (p. 133). Whether the analogy is a good one depends largely on whether it achieves its purpose (e.g., of predicting what will happen if the United States intervenes militarily in Kuwait). And whether it achieves its purpose depends on the structural relations between source and target, for example on whether the causally relevant features of the target have been mapped onto features of the source. If an analogy is successful, learning can occur in the form of abstracting from source and target a general schema which captures the patterns of relational

structure most relevant for the purpose of the analogy. For example, from parallel stories about attacking a fortress and putting out a fire, in each of which the agent cannot succeed by massive action from just one direction, the schema might be constructed: A target is difficult to overcome, because a large force cannot be aimed at it from one direction. Recognition of a new situation as falling under this schema will prompt the convergence solution of overcoming the target by aiming several small forces at it from different directions. This is the solution of the problem of how to use ionizing radiation to kill a tumour without killing the healthy tissue between it and the patient's skin.

Practitioners and theorists of informal logic will be most interested in the authors' proposals for evaluating analogically based inferences. They advance these proposals as aids to making such inferences rather than as aids to judging the analogical inferences of others; that is, they treat evaluation of analogical inferences as part of problem-solving rather than of critical thinking. They have basically two pieces of advice. First, seek analogues which share higher-order relations (e.g., facilitating, supporting, explaining, causing) which make possible system mapping, rather than analogues which are only superficially similar in their attributes or first-order relations. Second, seek multiple analogues, and see what follows from each of them.

These pieces of advice can be grounded in a theory of analogical inferences as involving determination relations. Whether a proposed solution will accomplish an intended goal is determined by a number of factors in the target situation. The presence or absence of each such factor, or the degree of its presence, contributes to, and in this sense partially determines, the outcome. For example, whether military intervention will repel an aggressive invader is determined partly by how well the intervening forces are supplied, not only with weapons and ammunition, but also with food and drink: "an army marches on its stomach". Such determination relations are higher-order relations. So selecting a source analogue which shares higher-order relations is more likely to produce a reliable inference than selecting a source analogue which does not. And, since resort to analogies is appropriate only where there is incomplete knowledge of a complex domain where many factors are relevant, no single analogue is likely to match a target situation with respect to all the variables which determine the value of the variable of interest (e.g., whether the invader will leave). Mapping several source analogues successively onto the target situation is likely to uncover more causally relevant dimensions of that situation, dimensions which would go unnoticed if a single source analogue were single-mindedly pursued. Choosing many source analogues which each share some higher-order relations with the target situation has a better chance of producing a good solution.

In the final chapter, the authors describe two programs in which they have implemented computationally the parallel satisfaction of the constraints of similarity, structure and purpose in analogical thinking. One of the programs models retrieval from memory of a source analogue for a given target, the other mapping

a given source analogue to a target. The output of such programs matches human performance in analogical thinking reasonably well, and compares favourably to that of competing computational models of analogical thinking.

The authors regard their theory as a partial contribution to understanding analogical thinking, and they conclude with a description of outstanding questions for investigation. On the question whether more effective use of analogies can be taught, they write:

Many courses on critical thinking include a component on analogy use and misuse, but it would be surprising if such instruction were very effective, given the impoverished views of analogy that are usually presupposed. (p. 264)

The authors think that their multiconstraint theory can provide a basis for instructing people how to avoid abuses of analogy, but are agnostic about whether any effective method can be devised for improving creative uses of analogy.

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CRITICAL THINKING, 2nd edition.

by John Hoaglund

Newport News: Vale Press, 1995. 666 pages. ISBN: 0-916475-077.
Paper. US \$29.45.

Reviewed by Don S. Levi

An author of a critical thinking textbook seems to be given a paradoxical mandate: help students to think for themselves by offering them lessons that seem to do the thinking for them. To justify its existence the book has to have a selling point, and this seems to mean that the book has to give students procedures to follow or techniques to master. The problem is that the procedures or techniques seem to function as substitutes rather than as aids for the thinking that students still need to do.

Hoaglund's book is a good example of how this can be a problem. He does an excellent job of teaching argument diagramming, and even someone like myself, who does not teach it, can see the value, in helping students to think about how the argument works, of lessons on serial, linked, convergent, and divergent (or compound) arguments.