7.1 Mental models: models in what sense?

In the study of intelligence as exhibited in logical reasoning, one of the most popular tools has recently been the notion of mental model. For instance, Philip Johnson-Laird has used this term as the title of an entire treatise on the cognitive psychology of logical reasoning.\(^1\) It is not my purpose here to discuss particular prior uses of the concept of mental model in the literature. Instead, I shall analyze the nature of the very idea of mental model. What precisely is meant by this term? What can be meant by it?

At first sight, this question seems almost redundant. Isn't the notion

of model one of the most fundamental concepts in contemporary logic, so much so that model theory is one of its central areas? Why should cognitive scientists' use of this term "model" raise eyebrows among logicians?

The answer is regrettably simple. As the terms "model" and "mental model" are used by recent cognitive psychologists, they have absolutely no connection with logicians' use of the term "model"—at least, no connection that has been spelled out, or can easily be spelled out. What is worse, the concept of mental model has not been explained in the literature with a clarity which would enable psychologists to use it in a theoretically respectable way. Its recent uses are, to put the point bluntly, a hopeless muddle of confusions.

In order to substantiate this charge, let us have a glimpse at what Johnson-Laird does. For instance, he tries to develop a "theory of syllogistic inferences" which he explains by means of certain individuals "playing the role" of objects falling within the scope of the syllogistic terms. The idea is intuitive, and not so far in motivation from what I myself once suggested. However, it has absolutely nothing to do with the model-theoretical conceptualizations of logicians, and Johnson-Laird's attempts to assimilate the two to each other are seriously misleading. If one takes Johnson-Laird's idea seriously, one soon discovers that, in many different syllogisms, one needs a much smaller cast than Johnson-Laird marshals to the stage. In fact, a single individual will suffice in each and every case. For instance, in Johnson-Laird's sample syllogism

(7.1) All the artists are beekeepers.
All the beekeepers are chemists.

ergo: All the artists are chemists.

one needs only one "actor" representing an arbitrary artist. Call him or her $a$. Then, by the first premise, $a$ is identical with one of the beekeepers and hence, by the second premise, with one of the chemists.

This way of thinking has nothing to do with the real models of the propositions in (7.1). The different models of the premises of (7.1) have sets of artists, beekeepers, and chemists in them, usually large sets. Model-