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A Maximized Hypothesis in the Framework of Scientific Cognition as Model-Based Reasoning

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In her leading analysis of model-based reasoning, Nersessian (2002) adopts a reliable strategy and suggests a 'mimimalist' hypothesis "that in certain problem-solving tasks human reason by constructing a mental model of the situations, events and processes in WM that in dynamic cases can be manipulated through simulation"(p.143). Alternatively, this paper argues for an adventurous maximized hypothesis in a generalized sense of the term of 'mental model' including any complex forms and any formats of mental representations, not limited to Johnson-Laird's and/or Gentner et al's concept(s) (Johnson-Laird, 1980; Gentner & Stevens, 1983).

It seems that there never is a linguistic reform in the field of cognitive science though we have had Brewer's proposals (Brewer, 1999) both of the term 'mental model' for Gentner's concept – In this sense, mental models are a subclass of theories – and of the term 'episodic model' or 'constructed schemata' for Johnson-Laird's concept. In order to avoid a potential conceptual confusion in the current literature on model-based reasoning (MBR), consequently, we suggest a distinction between the singular problem of mental models and the plural one. The singular problem of mental models is a question of what is the nature of mental models and of why such mental representations can be called as 'models'. Mental models in the singular problem only refer to internal mental representations used in reasoning and in generating both external representations and new internal representations; thus, they are characterized not by their particular forms, but by their internal status and their general cognitive functions in representing the reality and in reasoning processes. It is mental models in the generalized sense that should be used in arguments for model-based reasoning as a semantic process. According to this analysis, we need to have a generalized mental model theory in favor of a model-based view of scientific theories as a response to the issue of the nature of theories. The plural problem of mental models, on the other hand, is a question of the representational forms and/or formats of models in active memory that are used in model-based reasoning, for which Nersessian (2002) provides a detailed discussion. Her analysis shows that we need something to deal with the debates on the representational forms of models used in model-based reasoning. This thing is, as we call it, a working-memory-assembling (WMA) model of mental representations.

Working memory (WM) plays a central role in generating new mental models and in model-based reasoning. More importantly, working memory acts as a kind of *assembling* apparatus if more common and more realistic kinds of reasoning are those based on multi-models with multi-forms of mental representations. In the WMA model, we divide mental models, in a generalized sense and generated from information in long-term memory (LTM), into the three kinds: theoretical models (including those of Gentner's mental models), schematic models (such as Johnson-Laird's mental models), and imagery models (e.g., images in Kosslyn's account). Following the generations of three kinds of models, an integration of kinds of mental models with different formats happens in WM for a variety of cognitive tasks. Moreover, two important conclusions can be drawn from the WMA model. The first one is a negation of the conception of LTM as a Platonic universe of ideas. In other words, to represent a variety of objects, events, processes, and situations, a natural mind (and the scientific mind in particular) unlikely possesses both unlimited number and unlimited kinds of mental-representational forms such as images, prototypes, frames, schema, mental models, perceptual symbols, theories, and so on, as ready models for their use in MBR. Another conclusion is a negation of the epiphenomenalist misunderstanding in the case that several forms of mental representations involved in different kinds of modeling processes come together for a reasoning task. It is in working memory that many forms of mental representations are combined together in an integrated model that is used in a process of reasoning. In short, the WMA model suggests that the account of multi-model-and-multi-form-based reasoning is more valuable for the cognitive analysis in case studies of science.

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