Alphabet Arithmetic and ACT–R: A reply to Rabinowitz and Goldberg

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Introduction

How is human knowledge and memory organized? Recently, some researchers have suggested that knowledge is either "active" (e.g., Rabinowitz & Goldberg, in press) or "inert" (e.g., Anderson, 1993a). Theorists who claim that declarative knowledge is active suggest that memory is actively processed, symbol manipulation is not necessary, and that memory is organized in an associative network with inhibitory and excitatory links (Rabinowitz & Goldberg, in press). Theorists who claim that declarative knowledge is inert, or passive, suggest that declarative knowledge is acted upon by productions and gains strength by being accessed (Anderson, Conrad, & Corbett, 1993).

Rabinowitz and Goldberg (in press) have compared and contrasted these two models by running a series of experiments using the "alphabet arithmetic" paradigm. Rabinowitz and Goldberg (in press) presented subjects with a letter and a number. Subjects had to 'add' the number to the letter to generate the second letter. For example, for the problem $C + 3 =?$, subjects should respond F.

Rabinowitz and Goldberg (in press) had two conditions: a retrieval condition and a procedural condition. In the retrieval condition, subjects saw a small set of problems on which they received extended practice. In the procedural condition, subjects saw a large number of problems a few times.

Rabinowitz and Goldberg (in press) found that subjects in the retrieval condition memorized the problems, while subjects in the procedural condition used a "finger counting" procedure to arrive at the correct answer. At the end of the acquisition stage of the experiment, subjects in the retrieval condition were faster than subjects in the procedural condition. On a transfer task, however, subjects in the procedural condition were faster than subjects in the retrieval condition.

Rabinowitz and Goldberg (in press) claimed that this evidence was strong support for a "retrieval" model of knowledge representation where declarative knowledge is active, not inert, as Anderson (1993b) claims.

To examine this hypothesis, a very simple model of alphabet arithmetic was built using ACT–R (Anderson, 1993b).

Results

As Figure 1 shows, the model does a good job of modeling the actual data for both the retrieval and procedural conditions. In addition, the ACT–R model shows the same pattern of results on the posttest that the actual data does. The ACT–R model suggests that subjects are not only learning and strengthening productions, but also strengthening the associations between declarative working memory elements. The model suggests that subjects in the retrieval condition did memorize alphabet arithmetic facts, while the subjects in the procedural condition gained more experience traversing the alphabet itself, thereby strengthening the pertinent associations.

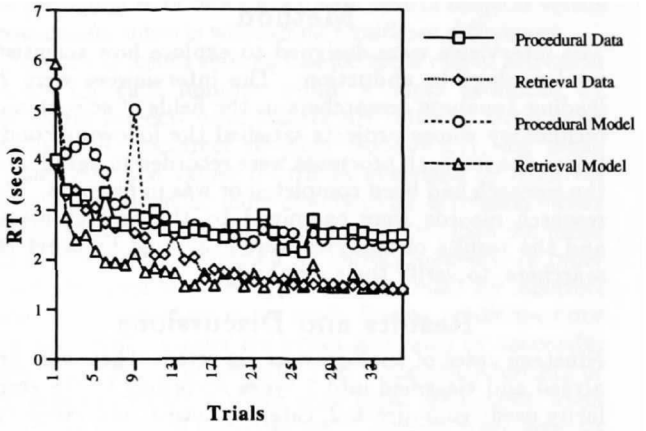

Figure 1: Reaction times (approximated) from Rabinowitz & Goldberg and model data from ACT–R.

In summary, ACT–R can successfully model the data presented by Rabinowitz and Goldberg (in press). This model suggests that the associations between memory elements are critical in this type of task.

References

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