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Individual Differences in Extrapolation of Function Learning

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Introduction

Investigation of concept learning has focused predominantly on categorization, in which stimuli are associated with nominal response categories. More recently, however, concept learning research has begun to focus on function learning, in which continuously-valued stimuli are associated with continuously-valued responses.

One particularly useful aspect of function learning is extrapolation - generating responses to novel stimulus values. Previous studies have found that regardless of training success, some participants extrapolate in accordance with the learned function whereas others do not (e.g., DeLosh, Busemeyer, & McDaniel, 1997; Griego, 2001). Although models of function learning have gained some success in reproducing human extrapolation performance (e.g., DeLosh, et al., 1997), they have not yet been able to *predict* who will extrapolate.

The purpose of this study was to determine if individual differences in extrapolation performance are related to problem solving in non-mathematical domains in order to gain a better understanding of the factors underlying function learning.

Method

Eleven undergraduate psychology students served as participants. They each completed a function learning phase of the experiment followed by a problem solving phase as described below.

Participants were first asked to learn the relationship between an organism's absorption of a newly discovered element, Zebon, and its release of another new element, Beros. During this training phase, participants were shown three vertical bars on a computer screen. The height of the first bar represented the amount of Zebon absorbed (input). The height of the second and third bars represented the predicted and actual amount of Beros released (output), respectively. Participants made their predictions by controlling the height of the second bar using the up and down arrow keys on the keyboard. The third bar was not revealed until participants made their predictions. Training consisted of 10 blocks of 20 trials. Training input values ranged from 81 to 119. Output values were determined by the mirror linear function: $y=230-2.2x$ if $x<100$; $y=2.2x-210$ if $x>100$. An extrapolation phase followed, consisting of 30 novel input values outside of the training range, with no feedback.

Next, participants were asked to read and summarize two text passages (each an analog to Dunker's radiation problem, see Catrambone & Holyoak, 1989). They were then asked to solve four matrix reasoning problems followed by Dunker's radiation problem.

Results

Extrapolation performance was assessed by calculating the mean absolute error (MAE) across the 30 extrapolation trials for each participant. MAEs ranged from 12.87 to 53.80. Previous studies have used 30 as a cut-off for classifying participants as having abstracted the function or not.

A multiple linear regression was performed using performance on the matrix reasoning problems and on Dunker's radiation problem to predict extrapolation performance. Together, performance on the matrix reasoning problems and Dunker radiation problem accounted for a significant proportion of the variability in extrapolation performance, $R^2=.828$, $SEE=6.15$, $F(2,7)=16.84$, $p<.01$. Inspection of the regression coefficients revealed that better performance on the matrix reasoning problems, but *worse* performance on Dunker's radiation problem, was associated with better extrapolation performance.

Discussion

Both extrapolation of the function and completion of the matrix reasoning problems required participants to induce a novel response that could only be generated by comparing multiple pieces of information. That is, successful extrapolation required use of more than just a single exemplar. Similarly, successful matrix reasoning requires consideration of all elements of the matrix. However, successful solution of the radiation problem could result from access to just a single analog. Thus, it is suggested that one factor that determines extrapolation is a tendency to process many sources of information in an analytic manner, rather than a tendency to look for a single similar exemplar (or at most a small number of exemplars).

References

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