Title
Implicit Learning and Deliberate Problem Solving: What is the Connection?

Journal
Proceedings of the Annual Meeting of the Cognitive Science Society, 21(0)

Authors
Nokes, Timothy
Corrigan-Halpern, Andrew
Ohlsson, Stellan

Publication Date
1999

Peer reviewed

Implicit Learning and Deliberate Problem Solving: What is the Connection?

Timothy Nokes (tnokes@uic.edu)
Andrew Corrigan-Halpern (ahalpe1@uic.edu)
Stellan Ohlsson (stellan@uic.edu)
Department of Psychology, University of Illinois at Chicago
Chicago, IL 60607-7513, U.S.A.

Introduction

Many theoretical proposals conceptualize the acquisition of deep knowledge as a deliberate, effortful and constructive process. In contrast, research on implicit learning of artificial grammars (Reber, 1989) suggests that learning is a passive, inductive process which is independent of any intention to learn and which creates knowledge not accessible to the learner. In the traditional artificial grammar paradigm participants first memorize letter strings that are generated according to a particular set of relational rules (the training phase). Participants are then given a new list of letter strings and are asked to identify those that are similar to the strings previously memorized (the test phase). Participants perform better than chance in the test phase, implying that an abstract representation is extracted from the training phase and used in the recognition task of the test phase (Reber, 1989).

What is the nature of the knowledge generated by the string memorization procedure? How does that knowledge function in subsequent processing? Can it support problem solving and other higher-order cognitive processes?

To investigate these questions, we revised the standard artificial grammar learning paradigm by replacing the string classification task typically used in the test phase with a letter sequence extrapolation problem (Simon, 1972). If what is learned in implicit pattern learning is available for deliberate problem solving, prior implicit learning of the relevant pattern should facilitate performance on sequence extrapolation.

Method

Participants. Eighty-four students from the University of Illinois at Chicago participated in return for course credit.

Materials. The target tasks were three letter sequence extrapolation problems; see Table 1 for an example.

Table 1: Letter sequence extrapolation problem 1.
For example, given the string

B D X E C Z E G X H F Z

Infer the 8-step extrapolation

H J X K I Z K M

There were 18 training strings consisting of 12 double-digit numbers, six for each of the three problems; see Table 2 for an example. The six number strings followed the exact same pattern as the associated letter sequence extrapolation problem. In addition, there were 18 strings of random double-digit numbers used in the control condition.

Table 2: Relevant training string for Problem 1.
For example,

13 15 35 16 14 37 16 18 35 19 17 37

Design and procedure. The participants were randomly assigned to either the *relevant training* group or to the *irrelevant training* group. Both groups solved the three sequence extrapolation problems. In the relevant training condition, the participants memorized number strings that embodied the same patterns as those in the extrapolation problems. In the irrelevant condition, the participants memorized the random number sequences.

Results and Discussion

Training. As expected, the relevant training group performed significantly better than the irrelevant training group on the memorization task [$p<.01$].

Problem Solving. The relevant group was slightly better than the irrelevant group on the problem solving tasks, but the difference was small in magnitude and it did not reach statistical significance [$p>.06$]. Also, performance on the memorization task did not correlate significantly with problem solving performance for two out of the three extrapolation problems.

There are at least two possible explanations. It is possible that although the participants did acquire the pattern underlying the number strings they memorized, their representation of that pattern was not abstract enough to transfer to letter sequences. A second explanation is that the pattern representation learned during string memorization is abstract but not generative. It can support familiarity judgments, but it cannot be equated with the abstract concepts, ideas and schemas that support higher-order thinking (Ohlsson & Lethtinen, 1997). Studies currently under way aim to resolve these issues.

References

Ohlsson, S. & Lehtinen, E. (1997). Abstraction and the acquisition of complex ideas. *International Journal of Educational Research, 27*, 37-48.

Reber, S., R. (1989). Implicit learning and tacit knowledge. *Journal of Experimental Psychology: General, 118*, 219-235.

Simon, H. (1972). Complexity and the representation of patterned sequences of symbols. *Psychological Review, 79*, 369-382.