Evaluation of a Direct Nonverbal Measure of Declarative Sequence Knowledge

Karin C. Japikse*, Darlene V. Howard*, & James H. Howard, Jr.[+]

*Georgetown University, Washington DC; [+] The Catholic University of America, Washington DC

Abstract

Studies of procedural sequence learning are complicated by difficulties in determining the extent to which declarative pattern knowledge has developed. Adequate measures of conscious knowledge are necessary for increasing confidence that any other observed learning is implicit in nature. This study evaluated a new measure of conscious sequence knowledge. Participants performed six sessions of an alternating serial response time task under either incidental or intentional instructions. Thus, while the former subjects were not informed of the presence of the pattern, the latter subjects were told the structure of the pattern embedded in the task and were asked to guess the pattern at the end of every block. At the end of every session, participants performed a production task and completed verbal questionnaires designed to probe for declarative knowledge. Then, at the end of the final session, they completed a sorting task in which they classified strings of spatial positions into frequency categories. Subjects who had demonstrated declarative knowledge on their end-of-block guesses sorted the cards into the three categories differently than those who had not. These results were consistent with performance on the production task as well. Thus, the sorting task provides a new measure of declarative knowledge that, together with verbal reports, can help differentiate between those with and those without conscious knowledge.

Introduction

The study of procedural sequence learning has been complicated by the tendency of subjects to develop conscious pattern knowledge. One strategy has been to increase sequence complexity (such as by using an alternating pattern rather than a simple repeating one), thus making it more difficult to gain declarative knowledge.

Previous experiments using an alternating sequence have used post-experimental interviews to probe for conscious pattern knowledge. In these experiments, no one verbally reported anything about the pattern that was accurate, suggesting that declarative knowledge had not developed (Howard & Howard, 1997). While such questionnaires are commonly used tests for declarative information, they may miss conscious knowledge that is not easily verbalized. Additional tests for pattern awareness, such as the production task, are non-verbal but may tap both procedural and declarative knowledge.

The goal of the present experiment was to evaluate the sorting task, a new direct, non-verbal test for declarative knowledge. To do this, we manipulated the instructions given to our participants so that some gained conscious pattern knowledge (as measured by verbal reports) while others did not. We then compared these two groups of people on the sorting task.

ASRT Task
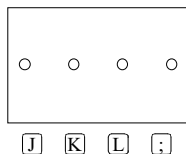
Each trial: One of four positions fills in and the participant must hit the corresponding key.

Sample Pattern: 1R2R3R4R

where 'R' denotes a trial on which any one of the positions may occur with equal probability

`J` `K` `L` `;`

Measure of learning: the difference between the pattern and random trials on response time and accuracy measures. (= the **trial type effect**).

Procedure

• For the ASRT task:
   Incidental Subjects:
      • Were not told of the presence of the pattern(s)
   Intentional Subjects:
      • Were told an alternating pattern would be present
      • Were not told its length
      • Were not told about the secondary blocks (if applicable)

• Participants performed the ASRT task for 6 sessions
   • Each session contained 210 repetitions of the pattern

Pattern Knowledge Probes

(1) ASRT Performance: RT and Accuracy
      • indirect measures
      • both procedural and declarative can contribute
(2) Verbal Reports:
      • Intentional: At the end of every ASRT block, were asked for current best guess of pattern.
      • Incidental: Were asked a series of questions at the end of every session.
      • direct measures of declarative knowledge
(3) Production Task:
      • given at the end of every session
      • instructions were to "press the keys to create a typical sequence"
      • can be an indirect or direct measure
      • both procedural and declarative can contribute
(4) **Sorting Task**
      • given at the end of the 6th (final) session.
      • Direct, non-verbal measure

Sorting Task

• Participants were told that some 3-position-long sequences (triplets) had occurred more frequently than others during the ASRT task

• Given 64 index cards, each depicting a different triplet

• Asked to sort the cards into 3 piles:
   • Occurred Most Often, Occurred Often, Occurred Least Often

Results

1. Six people verbally demonstrated full knowledge of the primary pattern.
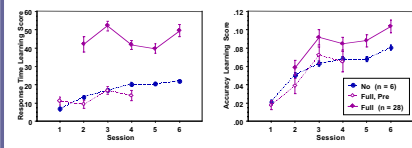
Intentional Group:
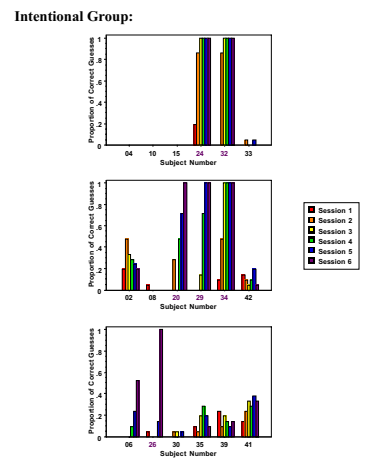
Incidental Group: No one accurately described anything about the pattern in the end-of-session questionnaires or the post-experimental interview.
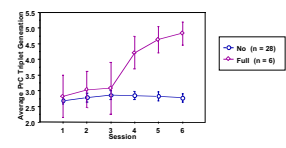
2. All participants showed pattern learning on the ASRT task.
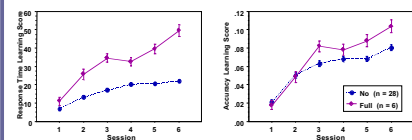
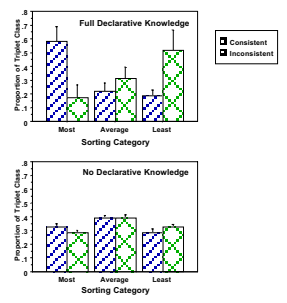**Performance improved once participants gained full declarative knowledge.**

3. Production Task Performance:

Those with full declarative knowledge produced more pattern-consistent triplets during later sessions.

4. Sorting Task Performance:

Those with full declarative knowledge:
   • **sorted more pattern-consistent triplets into the "Most" category than the other two categories.**
   • **sorted more inconsistent triplets into the "Least" category than the other two categories.**

Conclusions

• Only the group with declarative knowledge was able to perform the sorting task systematically. That is, this group sorted more pattern-consistent triplets into the "most often" category and more pattern-inconsistent triplets into the "least often" category.

• Thus, the sorting task might be a useful measure of declarative knowledge because ability to sort the cards well:
      • does not depend on ability to verbally describe the pattern
      • cannot be based on perceptual or motor fluency