The utility of implicit learning in the teaching of rules

Bjorn Saetrevik, Rolf Reber, Petter Sannum   In: Learning and Instruction 16  (2006)

1. Introduction

The term implicit learning was first introduced by Reber (1967) and describes a situation, where a person acquires knowledge about covariations („rules“) in the environment without explicit intention of learning, without awareness of the learning process and without the knowledge of what has been learned.

Reber et al (1989) claim to have shown that in experiments with an artificial grammar rules can be learnt implicitly. However, other findings suggest that participants in such experiments do not learn an abstracted rule but extract some probabilistic information about the composition of sequences.

Different alternative mechanisms have been proposed as involved in the implicit learning of regularities:

a) people extract similarities between training and test materials
b) people retrieve fragmentary knowledge about training materials
c) people experience higher processing fluency when a stimulus is regular rather than irregular an rely on this processing experience as information for the classification
d) implicit rule abstraction takes place

Although more evidence has been accumulated in favour of the first three hypotheses the issue has not yet been settled. Anyway implicit learning could be an importaant factor and a powerful tool for teaching at school and in everyday life. This was put forward by Reber (1993) when he claimed that by overemphasizing explicit and concious learning the importance of implicit processes is covered and neglected.

Several studies on implicit learning in language teaching (Robinson 1997, Shanks and St.John 1994) have shown, that in contradiction to Rebers hypotheses implicit learning support for rule abstraction cannot be observed even in longterm studies.

2. Experimental setting

The present study attempted to teach atomic bonding rules to children that were not previously exposed to chemistry. The atomic bonding rules was chosen because of their simplicity, the unlikeness of previous exposure and the fact that they will be taught later on in the curriculum. Moreover this approach extends the studies on implicit learning to a non-language domain.

The stimuli presented in the study were graphical representations of molecules, where the letters C, H, O represent the respective atoms and lines between the letters the atomic bonds. The rule to be transmitted by the graphic states that H must have one, O must have two and C must have 4 chemical bonds.
**Experiment 1a:**

After exposure to correct chemical molecules the participants were told that the stimuli were structured by a rule and asked to discriminate between correct and incorrect novel molecules. The same question was given to students which had been exposed to insignificant stimuli.

**Results:**

None of the two group performed significantly over chance level.

**Experiment 1b:**

Four groups were exposed to the same stimuli but with different tasks

<table>
<thead>
<tr>
<th>Group</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memorization group</td>
<td>Memorize the molecules</td>
</tr>
<tr>
<td>Count Atoms group</td>
<td>Count all atoms in the molecules presented</td>
</tr>
<tr>
<td>Count C-Bonds group</td>
<td>Count bonds of C-Atoms</td>
</tr>
<tr>
<td>Verify Rule group</td>
<td>Verify the rule, tha C-Atoms always have 4 bonds</td>
</tr>
</tbody>
</table>

Immediately after finishing all participants were tested for explicit and implicit learning

- **Open question:** write down the rule/how did You solve the task?
- **Strategy question:** did You use the rule in the previous task?
- **Rule Question:** which of the five alternatives most closely matches the rule?
- **Molecule question** How many bonds do H, O and C have respectively?

Questions 1 and 5 were used to distinguish learners from nonlearners

<table>
<thead>
<tr>
<th></th>
<th>Count Atoms</th>
<th>Memorization</th>
<th>Count Bonds</th>
<th>Verify rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>22.45</td>
<td>24</td>
<td>33.35</td>
<td>35.94</td>
</tr>
<tr>
<td>Effect size to chance level</td>
<td>.50</td>
<td>.52</td>
<td>.76</td>
<td>.94</td>
</tr>
<tr>
<td>Explicit knowledge</td>
<td>1/21</td>
<td>2/20</td>
<td>12/17</td>
<td>15/18</td>
</tr>
</tbody>
</table>

Facit:
Focusing on rule-relevant features led to high task performance and to increased explicit knowledge.
Some implicit learning takes place
**Experiment 2:**

The literature is unclear on whether implicit learning outcome depends on the complexity of the task. Experiment two therefore tested the same setting with less complex stimuli.

<table>
<thead>
<tr>
<th></th>
<th>Count Atoms</th>
<th>Memorization</th>
<th>Count Bonds</th>
<th>Verify rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>21.8</td>
<td>24.93</td>
<td>32.54</td>
<td>38</td>
</tr>
<tr>
<td>Effect size to chance level</td>
<td>.47</td>
<td>.77</td>
<td>.83</td>
<td>.99</td>
</tr>
<tr>
<td>Explicit knowledge</td>
<td>0/15</td>
<td>0/14</td>
<td>6/13</td>
<td>11/13</td>
</tr>
</tbody>
</table>

**Facit:**
Slightly better performance in explicit learning groups

**3. Discussion:**

The main goal of the study was to test whether implicit learning as reported by Reber (1967, 1993) can be replicated in an educational setting. The result is, that although some implicit learning takes place explicit learning is much more important both in more and less complex tasks.

Exp 1b and 2 show a slight effect of implicit learning. The fact that participants in Exp 1b got slightly longer training times than those in Exp 1a points to the importance for this factor for implicit learning.
4. References:


