Transfer of implicit perceptual-motor sequence knowledge across spatially-unique cue colors and shapes

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Implicit learning, or learning without conscious awareness outside the medial temporal lobe system, has been previously observed to be highly inflexible\(^1\).

Flexibility of the learned representation (such as task perceptual features) can be inferred from transfer amount, which is the expressed knowledge in a novel, unpracticed context.

**Research Question**: are acquired representations of implicit knowledge tied to perceptual information during learning?

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SERIAL INTERCEPTION SEQUENCE LEARNING (SISL) TASK

Participants **intercept moving cues** when they overlap with one of 4 targets by pressing keys corresponding to the target (D, F, J, K).

- Cues follow a covertly-embedded, 12-item **repeating sequence**. Example: K-F-J-D-K-D-F-K-J-F-D-J--...

**Implicit learning Measure: SSPA**

- **Sequence Specific Performance Advantage** = accuracy for practiced repeating sequence – accuracy for unpracticed novel sequences.

**Procedure:**

- **Training**: practiced the repeating sequence.
- **Test**: sequence knowledge was assessed under both the training and transfer conditions.

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Participants expressed similar levels of sequence knowledge across the test conditions with the Practiced color/shape and the Novel color/shape for both perceptual feature groups, $F(1, 52) = 0.156, p = .695$. 

**Color change** ($n=24$)

<table>
<thead>
<tr>
<th>Blue condition</th>
<th>Brown condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>F</td>
</tr>
</tbody>
</table>

**Shape change** ($n=30$)

<table>
<thead>
<tr>
<th>Circle condition</th>
<th>Square condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>F</td>
</tr>
</tbody>
</table>

**Transfer**

Participants expressed similar levels of sequence knowledge across the test conditions with the Practiced color/shape and the Novel color/shape for both perceptual feature groups, $F(1, 52) = 0.156, p = .695$. 

**Graphical representation**

- **X-axis**: Practiced, Novel
- **Y-axis**: SSPA (%)
- **Bars**: Color (Light Gray), Shape (Dark Gray)
- **Legend**: Changed feature (Color, Shape)
- **Statistical result**: n.s.
Participants expressed significantly less sequence knowledge in the transfer tests with **Shuffled** or **Novel** cue colors/shapes than in the **Practiced** condition for both perceptual feature groups, $F(2, 160) = 9.486$, $p < .001$. 

\[ p < .001 \] 
\[ p < .001 \] 
\[ p = 1.000 \]
CONCLUSIONS

- **Implicit learning is only affected by task-relevant feature changes**
  - Cue color or shape changes unrelated to task demands do not affect transfer performance.
  - Changes in cue-feature mapping create inflexible representations and impaired knowledge expression when remapped.
  - Sequence information is integrated in visual and motor cortices, in which the amount of accessible knowledge in a transfer test is determined by the strength of spatial-perceptual association acquired during learning.
REBER LAB

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