The Effects of Stimulus Similarity on N-Back Task Performance and Transfer

Michael B. Kranz, Erika Hussey, & Arthur F. Kramer

The Beckman Institute of Advanced Science and Technology, University of Illinois at Urbana-Champaign

Background

Recently, the n-back task has been used to improve working memory (WM) in cognitive training designs. Across studies, the stimulus type used in the n-back task often varies and each may rely on different WM systems (e.g., verbal vs. non-verbal). This feature, in turn, may afford different strategies. How different stimulus types affect training and transfer remains largely unclear.

We investigated the nature of stimulus similarity on training/transfer effects with n-back in two ways:

1.) Across multiple sessions. Subjects show performance improvement benefits not only after prolonged exposure to n-back in training paradigms, but also after just a single session (i.e., practice effects).

2.) Within a single session. Performance may decline on measures with shared processing demands due to cognitive fatigue.

Performance Across Sessions

Experiment 1

Does stimulus similarity influence n-back practice effects across sessions?

<table>
<thead>
<tr>
<th>Session 1 N-Back</th>
<th>Session 2 N-Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects completed 8 blocks alternating between 2- and 3-back that contained either:</td>
<td>All subjects performed a 3-back task with letters that were phonologically distinct, creating 2 groups:</td>
</tr>
<tr>
<td>1. Phonologically similar letters (high interference)</td>
<td>Same: Distinct Twice</td>
</tr>
<tr>
<td>Stimulus set: C D Z B P G T V (N=18)</td>
<td>Different: Similar &amp; Distinct</td>
</tr>
<tr>
<td>2. Phonologically distinct letters (low interference)</td>
<td></td>
</tr>
<tr>
<td>Stimulus set: Q F B R X M K H (N=14)</td>
<td></td>
</tr>
</tbody>
</table>

Performance on Part 1

Discriminability (A’)
- The non-verbal group performed worse than the word and hybrid groups (p<.05).

Response Bias (Grier’s B”)
- No effect of stimulus type (p>.05).

Performance on Part 2

Discriminability (A’)
- No significant effect of part 1 stimulus type on part 2 stimulus performance (p>.05).
- The non-verbal group performed significantly better on the non-verbal transfer stimuli compared to the verbal and hybrid groups (p<.05).
- No significant effect of group on verbal transfer stimuli (p>.05).

Response Bias (Grier’s B”)
- No effects of stimulus type (p>.05)

Discussion

1) In Experiment 1, we demonstrate that across sessions, varying stimuli within the same domain (e.g., letters) does not alter subjects’ performance compared to cases when the stimuli remain the same.
   - One exception is response bias on 2-back: subjects practicing the same letters were more conservative at session 2 compared to those seeing a new letter set. This suggests that subjects may be reaching a level of skill acquisition that allows them to free up resources to change response strategies.
2) In Experiment 2, we demonstrate that within a session, practice on a version of n-back with difficult non-verbal stimuli (squiggles) transferred to better subsequent performance on a version of n-back with a different non-verbal stimulus set (shapes).
   - These patterns are not aligned with a cognitive fatigue account.
3) Taken together, our results suggest that skill acquisition (practice) plays an important role in transfer during shorter bouts of task training.

References


For more information: mbkranz@illinois.edu