Relationships Between Memory Skills and Sound-Category Learning

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Abstract

• There is growing interest in the idea that certain aspects of language are best learned implicitly or procedurally, and models of impaired language like the Procedural Deficit Hypothesis suggest that procedural deficits are predictive of language-learning outcomes. [1]

• To test the hypothesis that language structure is best learned implicitly, we created a sound-categorization task in which optimal learning required participants to integrate information from two different cues (pitch and vowel quality). Similar tasks in the visual domain have been shown to be best learned implicitly. [2]

• In Experiment 1, 31 undergraduate participants completed assessments of procedural, declarative, and working memory and a sound-categorization task.

• In Experiment 2, 43 undergraduate participants completed the same memory assessments, but the sound categorization task consisted of twice as much speech-sound training distributed over 2 days, and trials were reordered to highlight the category boundary.

Methods

Sound Categorization Task

"vot"   "wadim"   "rud"

Procedural Memory Assessment: Verbal SRT

Working Memory Assessment: Listening Span

"The boy put out the fire with a bucket full of promises"
Sentence → "G" Letter → Did the sentence make sense? △ or ▽ Response → Type your response below Letter 1: Letter 2: Letter 3: Letter Recall

Declarative Memory Assessment: Paragraph Recall

Immediate Recall — "Anna Thompson of south Boston…" Story → Type your response below: Response

Delayed Recall — 20 minute delay → Type your response below: Response

Y/N Questions — Was Anna robbed on State Street? Question → Y or N Response

Analysis Variables

Sound-categorization task
• Block 6 Accuracy: categorization accuracy during final training block
Two measures of cue-weighting strategies (output from modeling[3]):
• First Linear Block: first block in which participant used a linear decision boundary (correlations with memory should be negative)
• Number of Linear Blocks: total number of blocks with a linear decision boundary

Procedural task
• Procedural prediction accuracy: accuracy for predicting third non-word in each series
Working-memory task
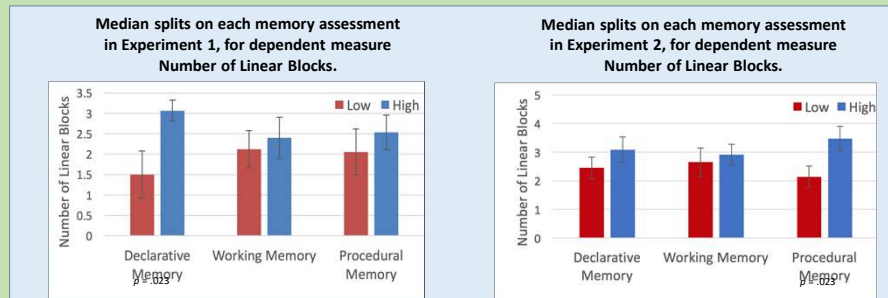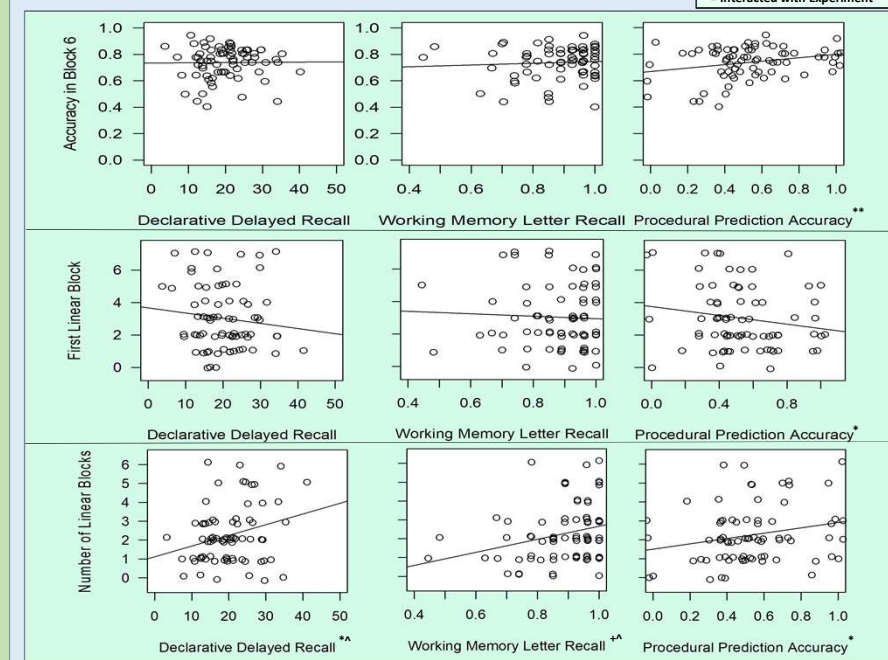• Letter-Recall Accuracy: accuracy for recalling three-letter sequences
Declarative task
• Declarative Recall: accuracy for retelling story details after a delay

Results

Median splits on each memory assessment in Experiment 1, for dependent measure Number of Linear Blocks.

Median splits on each memory assessment in Experiment 2, for dependent measure Number of Linear Blocks.

Combined Analysis:
Scatter plots (with best fit lines) for each dependent variable across experiments

Significance in ANCOVA:
+ = p < .1
* = p < .05
** = p < .01
^ = Interacted with Experiment

Conclusions

• Experiment 1 revealed effects of procedural memory, but also declarative memory, on sound-category learning accuracy and cue-weighting strategies.

• In Experiment 2, effects of procedural memory were replicated and effects of declarative memory went away, but new effects of working memory emerged.

• As predicted, the most consistent predictor of sound-category-learning outcomes across experiments was procedural memory. This provides some support for the Procedural Deficit Hypothesis. [1]
However, additional effects of declarative and working memory may be compatible with a multiple-systems account in which declarative and working memory facilitate transfer of control to the procedural system.

Citations

1. Lum, Conti-Ramsden, Page, & Ullman. (2012). Working, declarative and procedural memory in specific language impairment. *Cortex, 48*, 1138-1154.

2. Filoteo, J.V., Lauritzen, S., & Maddox, W.T. (2010). Removing the frontal lobes: The effects of engaging executive functions on perceptual category learning. *Psychological Science, 21*, 415-423.

3. Maddox, W.T., Koslov, S., Yi, Han-Gyol, & Chandrasekaran, B. (2016. Performance pressure enhances speech learning. *Applied Psycholinguistics, 37*, 1369-1396.

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