Links Between Sound-Category Learning & Memory Skills in Neurotypical & Language-Learning-Disabled Adults

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Background

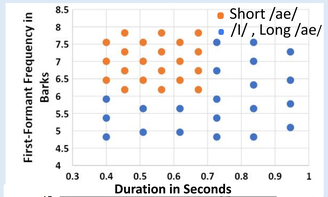
- Adults with a history of language-learning disabilities (LLD) often experience language-learning difficulties in adulthood.[1] This study seeks to test the Procedural Deficit Hypothesis (PDH),[2] which predicts that learners with a history of LLD will show particular deficits in procedural memory and implicit learning that will be linked with lower language-learning outcomes than neurotypical peers. We designed sound-category structures based upon work in the visual category-learning literature.[3] One is an "information-integration" structure argued to be best learned implicitly. The other is a "rule-based" structure argued to be best learned explicitly. We also assessed procedural-memory, working-memory, and declarative-memory skills.
- We hypothesized that, for the neurotypical (NT) group, procedural-memory skills would predict implicit category learning and declarative-memory skills would predict explicit category learning. We expected adults with a history of LLD to show a weaker connection between procedural memory and implicit category learning and to exhibit weaker performance at learning sounds implicitly, but not explicitly, when compared to neurotypical adults. We also predicted lower procedural-memory scores for the LLD group.

Methods

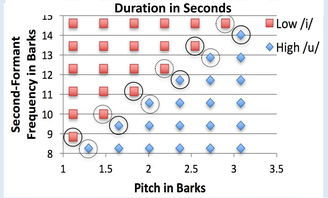
Participants: -43 neurotypical adult participants
-10 adult participants identified as having LLD via test battery (most of whom also reported a history of learning disability)

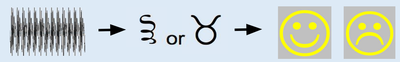
Sound Categorization Task

Explicit Task



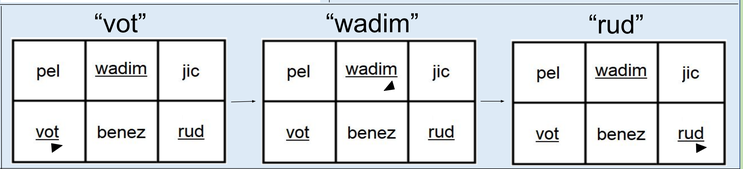
Implicit Task





Pairing of tasks and cues was counterbalanced across participants

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? → 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

20 minute delay

Delayed Recall

Type your response below: → Response

Y/N Questions

Was Anna robbed on State Street? → Question

Y or N → Response

Analysis Variables [4]

Procedural task

- Procedural Prediction Accuracy: accuracy after training for predicting third non-word in each series

Working-memory task

- Letter-Recall Accuracy: accuracy for recalling sequences of two-to-five letters

Declarative task

- Declarative Recall: accuracy for answering yes/no questions about story details after a delay

Sound-categorization task

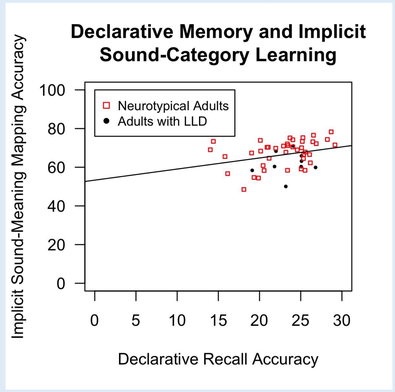
- Categorization accuracy over 6-7 training blocks.

Results

Multivariate Analysis of Variance (MANOVA) on Implicit Sound-Category Learning Accuracy

- Predictors: Block (0-6), Group (LLD, NT), Cues (pitch+F2, duration+F1), Procedural Prediction Accuracy, Working-Memory Letter-Recall Accuracy, Declarative Recall Accuracy.

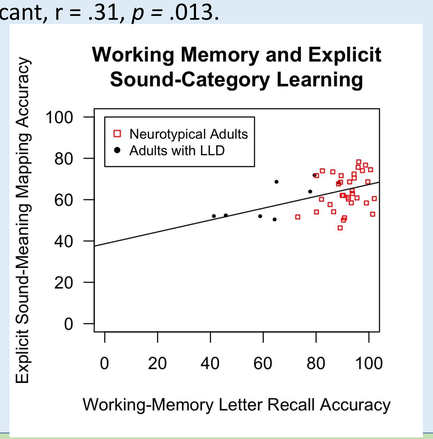
No effects of procedural-memory or working-memory skills. Only a main effect of Declarative Recall Accuracy: F(1,31) = 10.60, p = .003. Correlation: r = .29, *p* = .04.

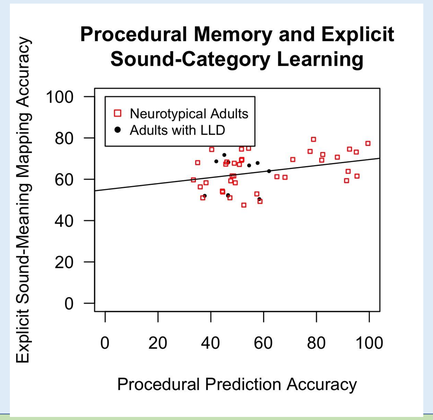


MANOVA on Explicit Sound-Category Learning Accuracy

- Predictors: Block (1-6), Group (LLD, NT), Cues (pitch+F2, duration+F1), Procedural Prediction Accuracy, Working-Memory Letter-Recall Accuracy, Declarative Recall Accuracy.

No effects of declarative-memory skills. Significant main effect of Working-Memory Letter-Recall Accuracy: F(1,31) = 7.85, *p* = .009. Correlation: r = .45, *p* = .003. **Effect of Procedural Prediction Accuracy that did not meet threshold for statistical significance:** F(1,31) = 3.79, *p* = .06, but a correlation test was significant, r = .31, *p* = .013.





Discussion

- Implicit sound-categorization accuracy was significantly associated with declarative-memory skills. In a prior study [4], we had found associations with all 3 memory domains across different experiments.
- Explicit sound-categorization accuracy was significantly associated with working-memory skills. There was also a significant correlation with procedural-memory skills.
- No effects of Group (LLD, NT) emerged in the MANOVAs, but LLD participants showed descriptively lower working-memory and procedural-memory accuracy than NT participants but typical performance for declarative memory. These patterns are consistent with prior work and roughly consistent with the PDH.
- Additional MANOVAs found no effects of sound-discrimination skills on category-learning accuracy, despite effects being found in preschoolers.[5] However, preliminary inspection suggests LLD participants' discrimination was lower than NT participants' for some cues (e.g., pitch) but not others.

CONCLUSIONS:

Based on the predictions of the PDH, we expected that procedural memory would be associated with implicit sound categorization, while declarative memory would be associated with explicit sound categorization. The results did not support these predictions. While no differences between groups emerged in MANOVAs, descriptive comparisons suggest group differences are somewhat consistent with the predictions of the PDH.

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