Impaired Incidental Learning of Complex Sound Categories in Children and Adults with Developmental Dyslexia

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Introduction

- Developmental dyslexia (DD) is commonly thought to arise from phonological deficits (Snowling, 2000). However, other theoretical frameworks indicate a procedural learning impairment in dyslexia (Nicolson & Fawcett, 2011; Ullman, 2004).
- Procedural learning mechanisms subserve the acquisition of speech categories, especially under incidental learning conditions.
- A procedural learning deficit could influence the resolution of phonological categories through an impaired perceptual learning process (Gabay & Holt, 2015).
- Typically developed (TD) adults can incidentally learn auditory categories which mimic the complexity of speech categories (Gabay, Dick, Zevin & Holt, 2015). However, adults with DD showed poorer performance in online incidental learning of nonlinguistic auditory categories and in categorization of novel exemplars (Gabay & Holt, 2015).
- Little attention has been directed to incidental learning in earlier development in dyslexia, though the investigation and identification might be useful for developing new interventions.

Research Question

How is incidental learning of complex sound categories affected in DD across development?

Method

Participants: Adults with DD; N=21 (M=24.22) and TD adults, N=21 (M=23.66). Children with DD; N=21 (M=10.35) and TD children, N=26 (M=10.33). Each two groups were matched for cognitive abilities and age. All were native speakers of Hebrew.

Stimuli: (1) Two unidimensional categories (category membership can be determined by a single acoustic property) (2) two multidimensional categories (there is no single acoustic property).

Task: The Systematic Multimodal Associations Reaction Time (SMART) task (Gabay et al. 2015); Sound stimuli preceded the visual cue.

Implicit learning measures-
(1) **Reaction time (RT) Facilitation**; Decrease in detection time along the repeated blocks 1-6.
(2) **RT Cost;** RT block 6 (repeated) < block 7 (random)
Explicit learning measure-
(1) **Post-Test Categorization** accuracy of novel category exemplars is above chance level (0.25).

Procedure: The experiment was conducted in one session.

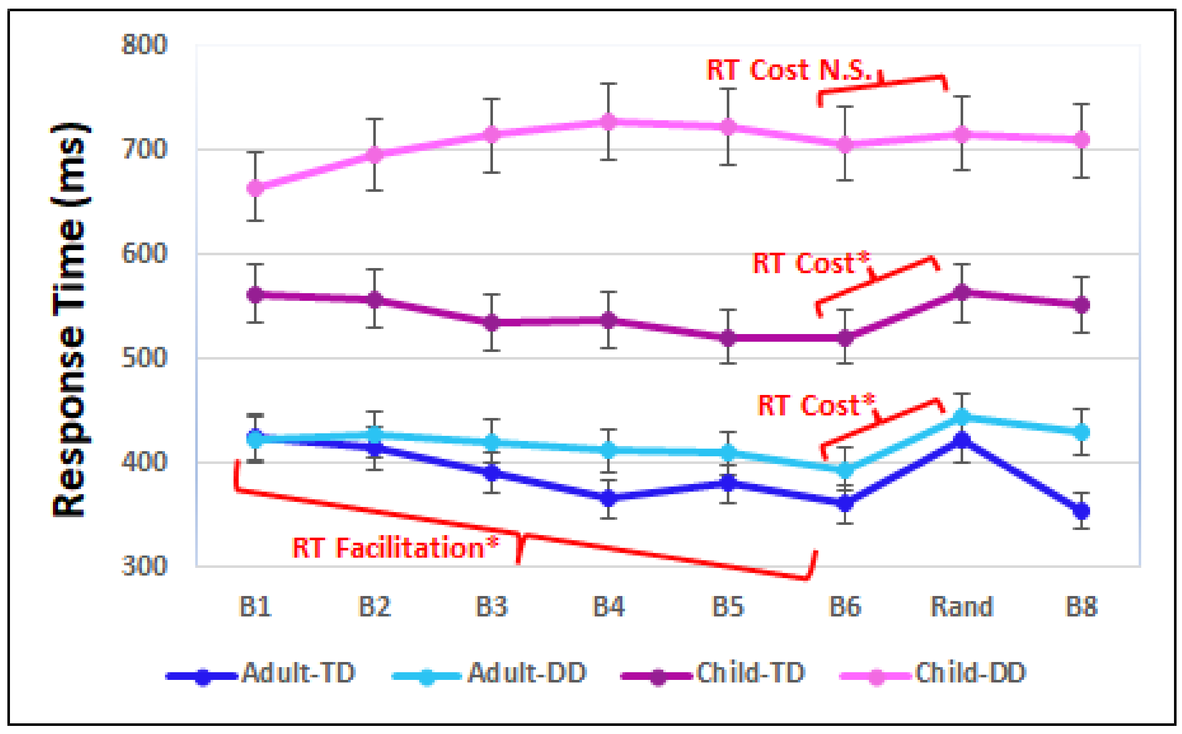
Results

Adults

- A significant Group X Block interaction was found in **RT Facilitation**, F(5, 200)=2.336, *p*=.043.
- A significant main effect of **RT Cost** was found, F(1, 40)= 24.33, *p*<0.001.

Children

- A significant Group X Block interaction was found in **RT Facilitation**, F(5, 225)=4.692, p<.001.
- A significant interaction of group by **RT Cost** was found, F (1, 45)=5.985, *p*= .018.

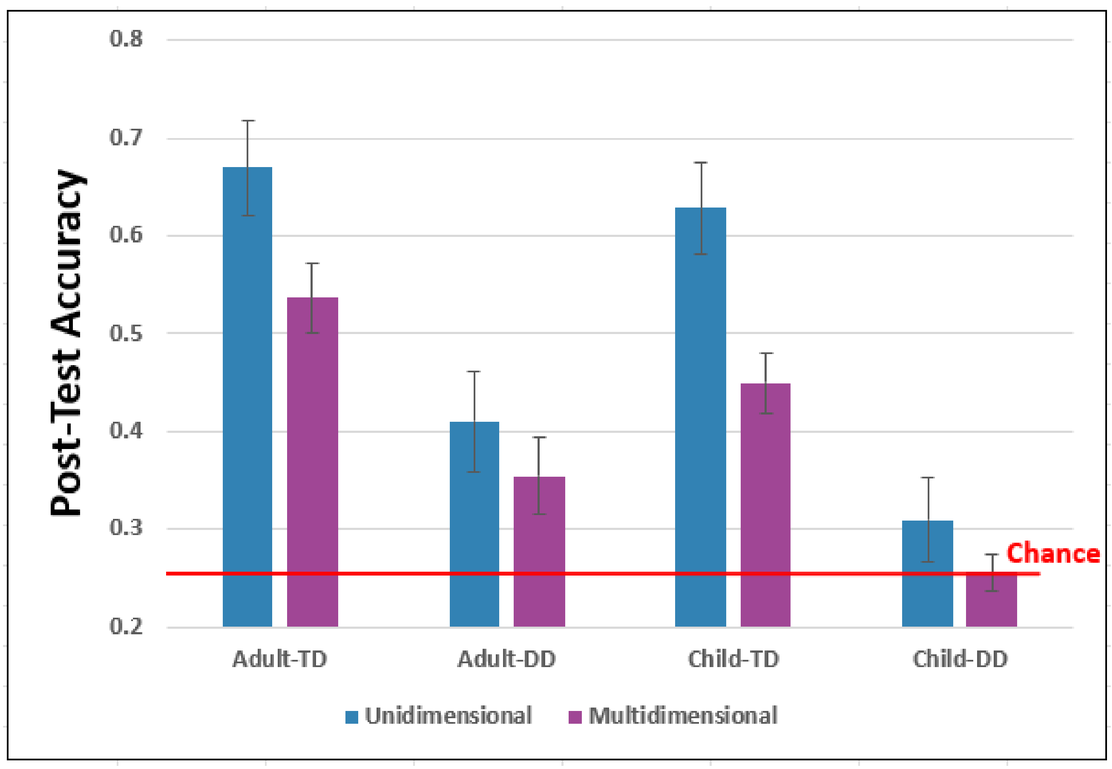


Adults

- All participants labeled novel generalization stimuli at above-chance level in the **Post-Test Categorization**, *t*(41)= 7.948, *p*< .0001 (M=49.3%, SE= 0.03).
- TD group performed significantly better than DD in **Post-Test Categorization**, t(40)= -4.33, p< .0001.

Children

- Only TD participants labeled novel generalization stimuli at above-chance level in the **Post-Test Categorization**, *t*(25)= 5.901, *p*< .0001 (M=53.9%, SE= 0.03).
- TD group performed significantly better than DD in **Post-Test Categorization** , *t*(45)= -5.532, *p*< .0001.
- A significant Category type X Group interaction was found, F(1, 45)=5.817, *p*= .020.



Conclusions

- Children with DD showed a reduced propensity to generate nonlinguistic sound categories in incidental learning conditions in which their peers were able to form the categories.
- This reduced propensity may impact the resolution of phonological representations and, in turn, reading ability.
- However, incidental auditory category learning impairments in DD are more prominent during early development than in adulthood.

Related Literature

Gabay , Y., Dick, F. K., Zevin , J. D., & Holt, L. L. 2015). Incidental auditory category learning. *Journal of Experimental Psychology: Human Perception and Performance, 41* (4), 1124.
Gabay , Y., & Holt, L. L. (2015). Incidental learning of sound categories is impaired in developmental dyslexia. *Cortex, 73*, 131-143.
Nicolson, R. I., & Fawcett, A. J. (2011). Dyslexia, dysgraphia, procedural learning and the cerebellum. *Cortex, 47* (1), 117e127.
Ullman, M. T. (2004). Contributions of memory circuits to language: The declarative/ procedural model. *Cognition 92* (1-2), 231-270.

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