



# TWO FORMS OF IMPLICIT LEARNING IN YOUNG ADULT DYSLEXICS

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## BACKGROUND AND PURPOSE

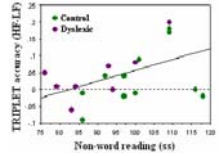
- **IMPLICIT LEARNING:**
  - Extract regularities from the environment without awareness (Reber, 1993)
  - Underlies the acquisition of many skills, including reading (Gombert, 2003)
- Two forms of implicit learning reveal a mixed pattern of results in adult dyslexics
  - **PERCEPTUAL MOTOR SEQUENCE LEARNING:**
    - Impaired in dyslexia (Howard et al., 2006; Stoodley et al., 2006)
    - Preserved in dyslexia (Kelly et al., 2002; Russelet et al., 2006)
  - **IMPLICIT SPATIAL CONTEXT LEARNING:**
    - Superior in dyslexics vs. skilled readers (Howard et al., 2006)
- **PROBLEM:** previous studies used sequence learning tasks with strong motor component
  - Cerebellar deficit hypothesis of dyslexia (Nicholson, Fawcett & Dean, 2001)
    - Difficulty learning new skills and performing them automatically
    - Abnormal cerebellar structure/function (Rae et al., 2002; Nicholson et al., 1990)
- **PURPOSE:** determine if deficits occur without motor sequencing
  - Perceptual sequence learning task without motor sequencing (TRIPLET)(Howard et al., 2004)
  - Spatial context learning task (CONTEXTUAL CUEING)(Chun & Jiang, 1998)
  - Neuropsychological tests of reading ability (Woodcock & Johnson, 1990)

## INDIVIDUAL LEARNING AND READING ABILITY

Learning task	Sequence learning		Contextual cueing	
	real word	non-word	real word	non-word
Howard et al. (2006)	+ .59 *	+ .52 *	- .44 *	- .50 *
Current study	+ .18	+ .48 *	- .28	- .13

\* = Significant

- Poor reading ability associated with:
  - Impaired perceptual motor sequence learning
  - Impaired perceptual sequence learning
  - Preserved/superior spatial context learning



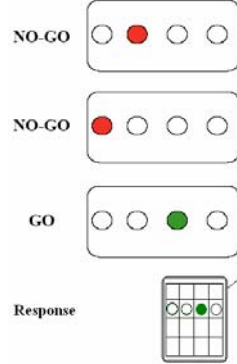
## TRIPLET TASK

- 9 Dyslexic (M=20.1 ± 0.8 years)(8 female)
- 12 Control (M=20.5 ± 1.9 years)(10 female)

- View stimuli at 1 of 4 locations
- 2 NO-GO events then 1 GO event per trial
- Respond only to GO event

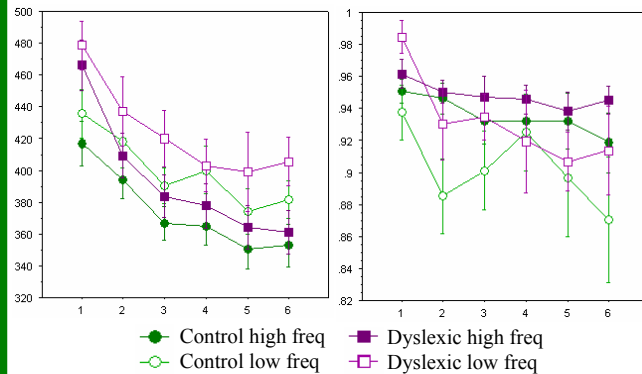
- 2<sup>nd</sup> order structure: location of 1<sup>st</sup> NO-GO event predicts target location on GO event
- Triplets: some runs of 3 events occurred more frequently than others (probability ratio 9:1)

- 30 blocks of 50 trials divided into 6 epochs
- Implicit learning: compare high frequency vs. low frequency triplets



REACTION TIME (ms)

ACCURACY (prop correct)



### REACTION TIME:

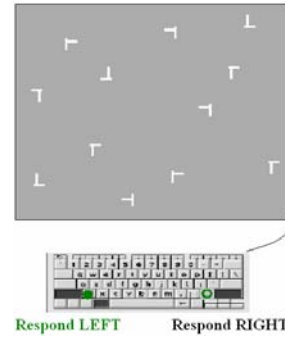
- Implicit learning in both groups
  - Dyslexic ( $p < .001$ ), Control ( $p < .001$ )
- No group diff in learning ( $p > .39$ )
- No group diff in speed ( $p > .25$ )

### ACCURACY:

- Implicit learning in both groups
  - Dyslexic ( $p < .03$ ), Control ( $p < .05$ )
- No group diff in learning ( $p > .36$ )
- No group diff in accuracy ( $p > .33$ )

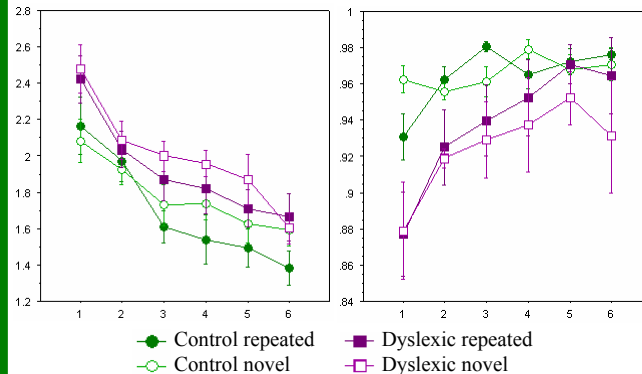
## CONTEXTUAL CUEING TASK

- 1 dyslexic did not participate
- View arrays of 11 distractors (offset L's) and 1 target (horizontal T)
- Respond to orientation of target T tail
- 24 trials per block
  - 12 arrays repeated across blocks
  - 12 novel arrays
- 30 blocks divided into 6 epochs
- Implicit learning: Compare repeated vs. novel arrays



REACTION TIME (sec)

ACCURACY (prop correct)



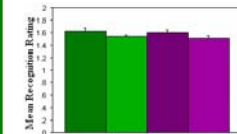
### REACTION TIME:

- No significant learning ( $p > .14$ )
  - Dyslexic ( $p < .51$ ), Control (trial type  $p < .10$ ; trial type x epoch  $p < .02$ )
- Controls marginally faster ( $p < .10$ )

### ACCURACY:

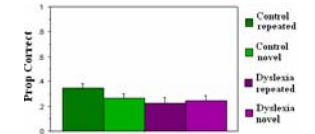
- No significant learning ( $p > .13$ )
  - Dyslexic ( $p < .08$ ), Control ( $p < .73$ )
- Controls more accurate ( $p < .04$ )

## NO EXPLICIT AWARENESS



TRIPLET

- Recognition task: equal recognition of high and low freq triplets in dyslexics ( $p > .12$ ) and controls ( $p > .05$ )
- Post-experiment interview: No subject accurately described the regularity



CONTEXTUAL CUEING

- Recognition task: equal recognition of target quadrant for repeated & novel arrays in dyslexics ( $p > .70$ ) and controls ( $p > .13$ )
- Post-experiment interview: 3 controls & 2 dyslexics felt some arrays were familiar

## SUMMARY AND DISCUSSION

- **PERCEPTUAL SEQUENCE LEARNING**
  - Group analysis: Dyslexics = Controls
    - Suggests motor sequencing deficit contributed to perceptual motor sequence learning impairments in earlier studies
    - Consistent with cerebellar deficit theory of dyslexia
  - Individual analysis: Poor reading skill related to impaired sequence learning
    - A reminder that pathology and behavioral pattern of dyslexics ≠ poor readers
- **SPATIAL CONTEXT LEARNING**
  - Group analysis: Neither group showing reliable implicit learning
  - Individual analysis: In direction of poor reading ability relating to more learning
    - Consistent with superior learning seen in Howard et al. (2006)
- Dyslexics do not have generalized implicit learning deficits: Future studies are necessary to clarify the nature of their spared and impaired implicit learning abilities

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