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Perception of coarticulation in gated words by dyslexic and non-dyslexic children

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Introduction

- Many, though not all, dyslexic children show performance on phonemic awareness tasks below what is predicted on the basis of their reading level
- Joanisse et al. (2000) divided these children into those with broader language impairments (Language-Impaired dyslexics), vs. those without (Phonological dyslexics)

- Many more Phonological dyslexics than Language-Impaired
- Further result: Only some of the Language-Impaired dyslexics were impaired in categorization of synthetic speech stimuli
- Phonological dyslexics were normal in their speech perception

Further questions

1. What is the nature of dyslexics' difficulty in phoneme awareness tasks? Common view is "degraded" or "poor" lexical representations, but if this is the case there should be problems in their daily speech
2. Could Phonological dyslexics have a subtler speech perception problem not picked up by categorical perception tests?

This study

- Test perception and use of anticipatory coarticulatory information in a gating task
- Normal performance on this task requires adequate auditory perception, adequate lexical representations, and adequate phonological processing
- Define Phonological and Language-Impaired groups independently to compare these factors directly

Anticipatory coarticulation

- Normal listeners use acoustic cues to upcoming segments (anticipatory coarticulation information) surprisingly early in their uptake of the signal
- Warren and Marslen-Wilson 1987, Lahiri and Marslen-Wilson 1991: normal adult listeners can use the anticipatory nasalization at the *beginning* of a preceding vowel to infer that a nasal consonant will follow
- West 1999: similarly, early anticipatory cues to postvocalic /r/ and /l/

Gating task

- Subjects hear portions of words ("gates") and guess at the whole word
- High frequency words are easier
- Children need longer portions of words than adults do to guess whole words, and the first sound of a word is not so helpful to them
- Usefulness of anticipatory information to children has not been tested, but should be a more sensitive test than guessing whole words

Previous studies of gating with dyslexic children

- Griffiths & Snowling 2001: Dyslexics aged 8–12
- Metsala 1997: Dyslexics aged 6–12
- Both studies tested the number of gates needed to guess whole words
- Neither found an overall difference between dyslexics and controls
- Metsala found a group difference on words from sparser neighborhoods – dyslexics did not show an advantage for them as controls did

Method: Subjects

- 23 dyslexics, 23 controls
  - Dyslexics at or below 25th percentile on one or two subtests of Woodcock test of reading ability (words, nonwords)
  - Normal controls at or above 40th percentile on both subtests
- Dyslexics age 9–14, controls 7–14

  (groups not significantly different)
- All subjects have normal performance IQ

  (groups not significantly different)

Standardized Tests for classifying subjects

- Woodcock Johnson Tests of Reading Ability
  - Word Identification (real words)
  - Word Attach (nonwords)
- WISC III IQ Tests
  - Verbal
    - Vocabulary
    - Similarites
  - Performance
    - Block Design
    - Picture Completion
- CELF-R Tests of Oral Language
  - Recalling Sentences
  - Concepts & Directions
- Vocabulary
  - ROWPVT
- CTOPP Tests of Phonemic Awareness
  - Elision
  - Segmenting Nonwords
- CTOPP Nonword Repetition

Further subgroups based on these tests

- CELF-R Recalling Sentences, CELF-R Concepts and Directions tests used to divide 23 Dyslexics:
  - 9 language-impaired (LI) dyslexics (scaled score below 7)
  - 14 non-LI dyslexics
- CTOPP Elision test used to divide 23 Dyslexics:
  - 13 phonological (PH) dyslexics (scaled score below 7)
  - 10 non-PH dyslexics

Method: Wordlist

- Two kinds of anticipatory coarticulation:
  - from nasal /n/
  - from liquid /l/
  - compared with oral stops

  ("FinalCCClass")
- Minimal pairs or triples
- High and low frequency wordsets

Items

Higher frequency:

- can–cat
- clown–cloud
- seen–seat
- bone–bowl–boat
- feel–feet

Lower frequency:

- rang–rag
- pan–pad
- dawn–dot
- cone–coal–code
- sweat–swell

Gates

Gates were of unequal durations:

1. Initial consonant(s) plus 25 msec of vowel
2. Plus next 25 msec of vowel
3. To 25 msec from end of vowel
4. Through end of vowel
5. Plus final consonant(s)

   (= Original recording of whole word)

Listen to sample stimuli on laptop

CONE	COAL	CODE
gate1	gate1	gate1
gate2	gate2	gate2
gate3	gate3	gate3
gate4	gate4	gate4
gate5	gate5	gate5

Procedure

- Stimuli presented by headphones, responses audio-recorded
- Items blocked by gate (not by word)
- Children give any guess they like about what word a fragment could have come from (they do not know what words they will hear)

Scoring

Responses scored for gate at which

- correct match to whole word ("WholeWord") like previous studies
- correct feature of final C ("FinalFeature") unlike previous studies

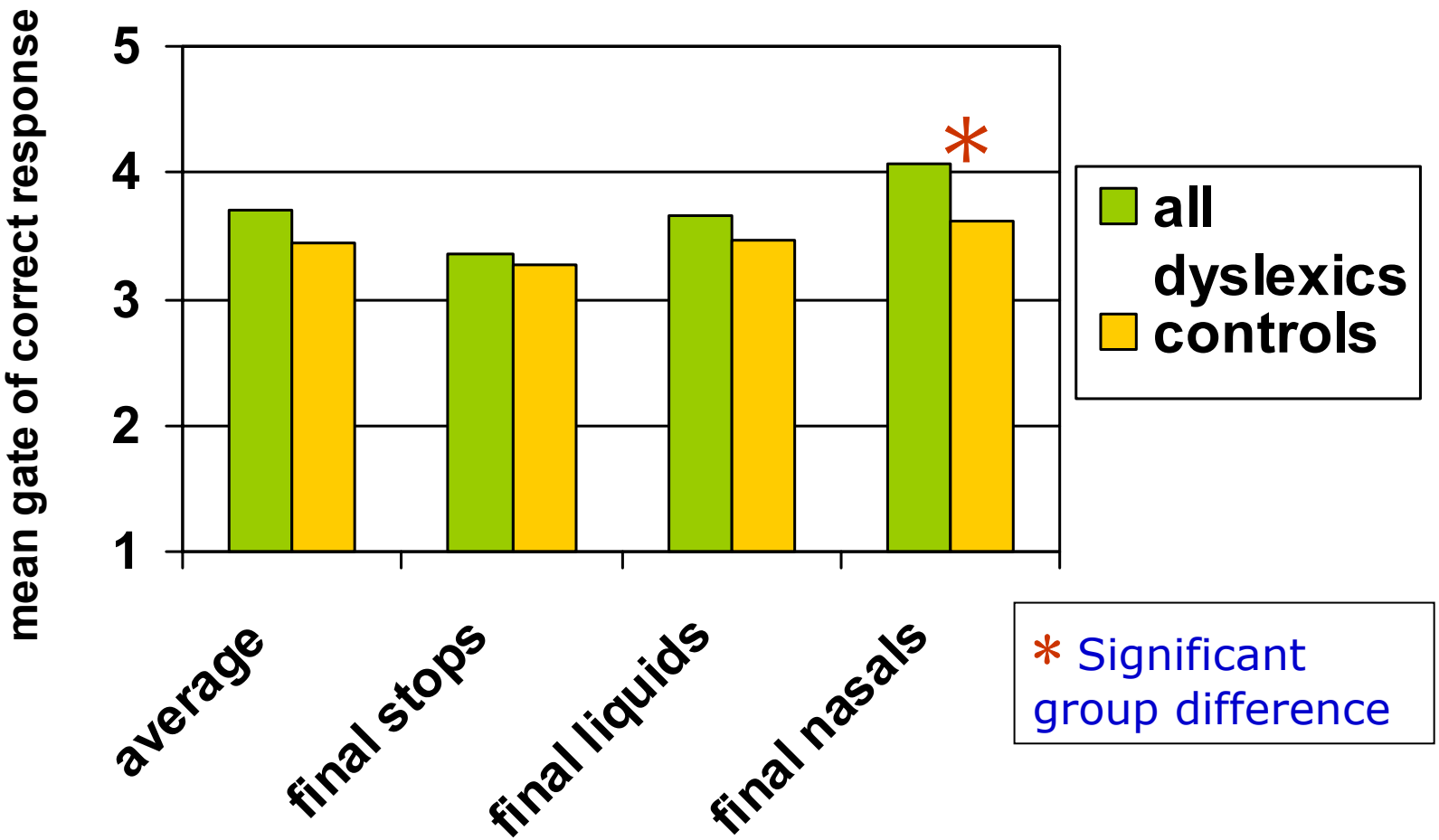
* Examples: *comb* for *cone*, *cold* for *coal*

- Best possible score = 1 (= first gate)
- Worst possible correct score = 5 (= last gate)
- Missed word scored as "7"

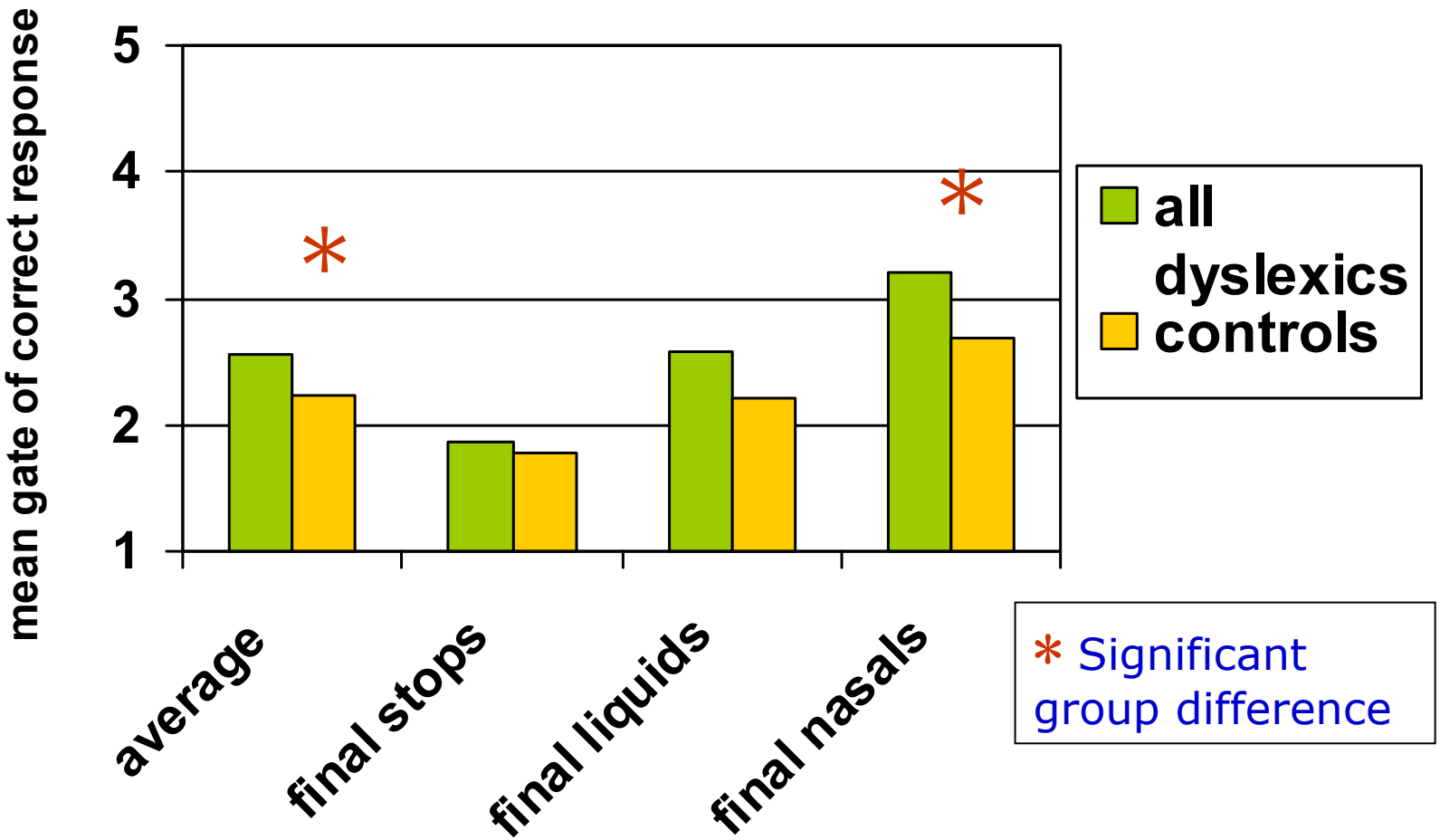
Data analysis

- ANOVAs on scores for WholeWord, FinalFeature
- Within-subject factors FinalCClass, Frequency
- Between-subject Group factors

Results: Effect of FinalCClass on Gate of WholeWord



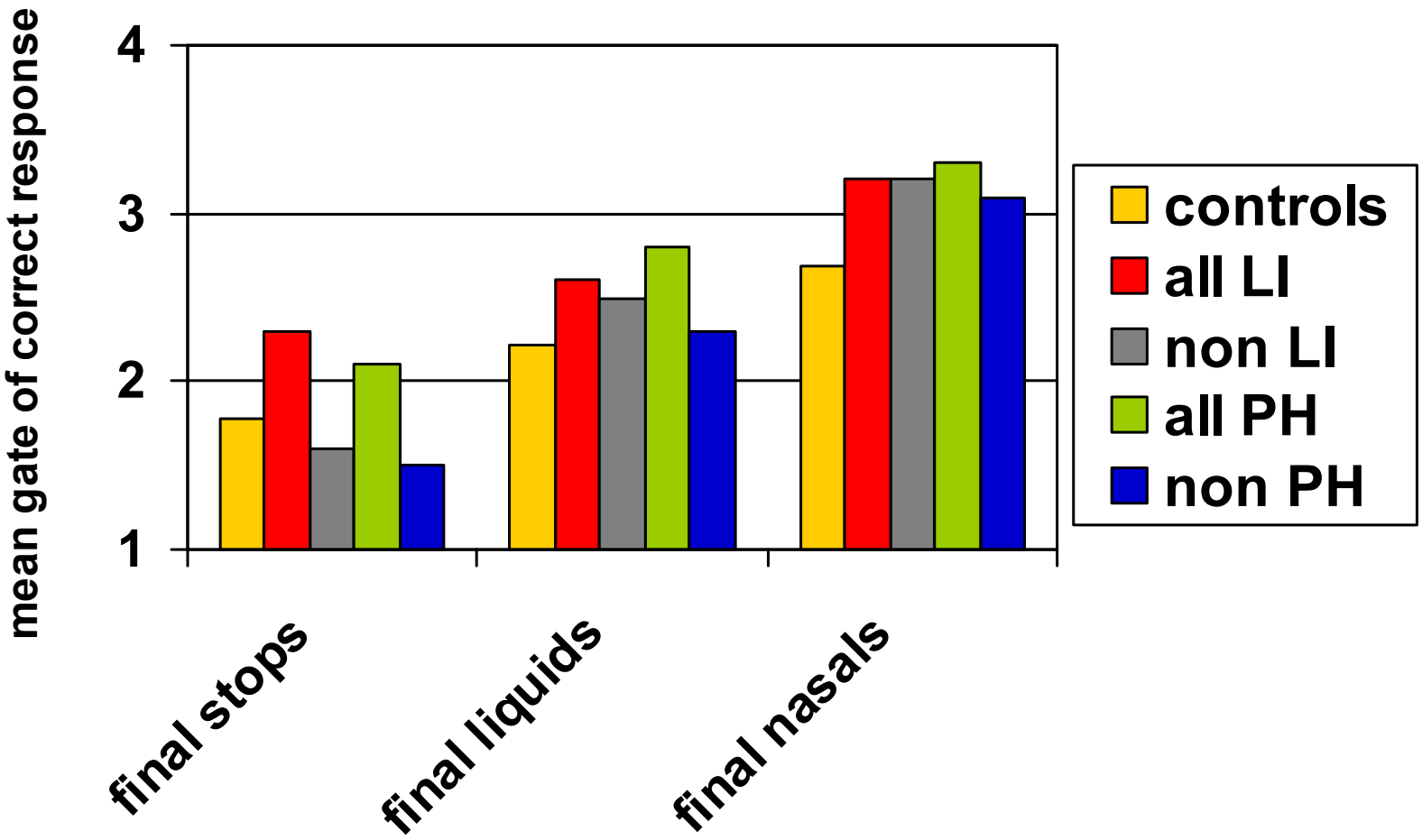
Results: Effect of FinalCClass on Gate of FinalFeature



Results: All dyslexics

- Final nasality is harder than other final consonant features for everyone, and dyslexics are significantly worse than controls on FinalFeature and Whole Word measures in nasal-final words

Results: Effect on FinalFeature by dyslexic subgroups



Results: Dyslexic groups

- Overall, PH and LI groups are worse than other dyslexics, but group effect is found for final nasals, where all dyslexics do worse than controls
- PH vs. non-PH dyslexics differ reliably, but LI vs non-LI dyslexics do not

Results: WholeWord recognition

- 3 of 9 language-impaired dyslexics had some trouble recognizing WholeWords from the last gate
- These 3 also worse on speech perception tasks (identification and cross-category discrimination) and Nonword Repetition
- Only 1 of the 3 has a low vocabulary score

Results: Word frequency

- Main effect of word frequency on FinalFeature: low frequency words are easier overall – perhaps they have more anticipatory coarticulation (Scarborough 2004)
- Dyslexics, specifically LI group, are worse than controls on high frequency (=harder) words, on FinalFeature and WholeWord

Regression analyses

- Gating (FinalFeature) contributed unique variance to the Phoneme Elision test of phonemic awareness
- Phoneme Elision contributed to reading performance
- Gating did not contribute directly to reading

Discussion

- Poor performance on gating could arise from problems with any of its component abilities: auditory perception, lexical representation, lexical access
- Even dyslexics with good phoneme awareness and speech perception are impaired on gating with final nasal consonants

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