

# Gradient perception of within-category acoustic detail by normal and language impaired listeners.



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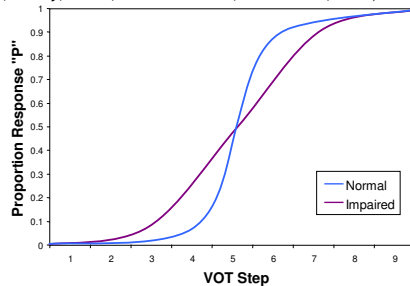
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## Background

### Language Impairment and speech perception

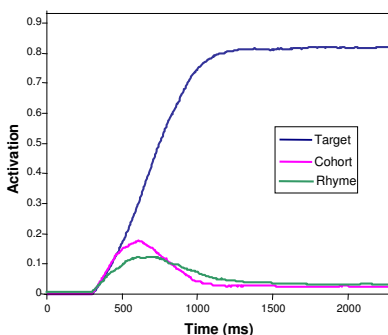
- Some approaches to language impairment (LI) posit deficits in speech perception or phonological representation as underpinnings of broader language impairment.
- Research has shown that children with specific language impairment may have deficits in **categorical perception** (e.g. Tallal & Piercy, 1974; Sussman, 1993).
  - *LI children are less categorical than their peers.*
- It has also been suggested that these deficits are merely a function of task demands and stimuli (Coady, Kluender, & Evans, 2005; Coady, Evans, Mainela-Arnold, & Kluender, 2007).



## Reframing the Question

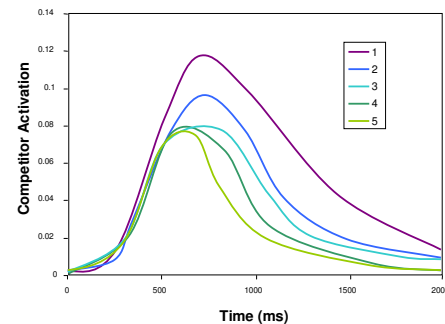
### Sensitivity to subphonemic detail

- Research in normal listeners suggests that categorical perception is largely an **artifact of task** (e.g. Schouten & Van Hesse, 1992).
  - Categorical perception may not be the right way to measure speech perception *in any population*.
- **Online spoken word recognition** offers an alternative.
  - Recognition unfolds over time.
  - Multiple items available in parallel.
- On-line word recognition studies show that listeners hearing a target word (*sandal*) temporarily activate:
  - target (*sandal*)
  - rhymes (*candle*)
  - cohort (*sandwich*)



## Word Recognition & Speech

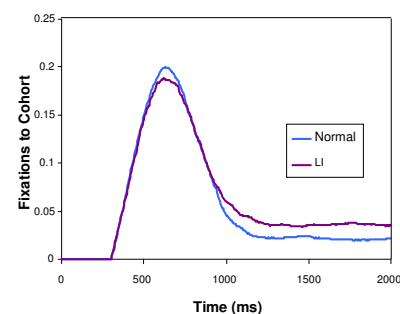
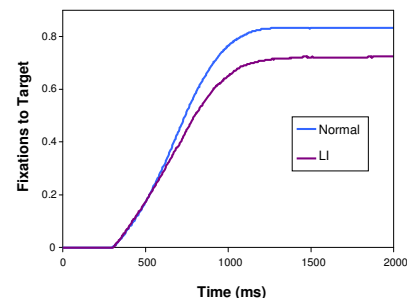
- In word recognition, issues of categorical perception can be reframed as whether within-category acoustic detail is preserved (gradient) or discarded (categorical) (McMurray, Aslin, Tanenhaus, Spivey, and Subik, in press; McMurray, Tanenhaus, 2002; Andruski, Blumstein & Burton, 1994).
  - in patterns of lexical activation
  - during online recognition



- *Deficits in categorical perception suggest that language impaired listeners may have too much of a good thing.*
  - Could be due a sensory deficit (e.g. Tallal)
  - Alternatively, it is possible that higher level lexical processes could be at fault.

### Word Recognition in Language Impairment

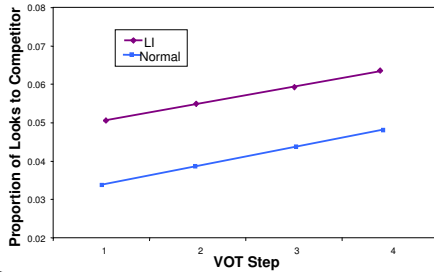
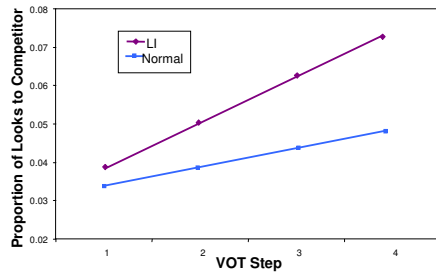
- LI adolescents show less activation for targets and increased activation for cohorts and rhymes compared with their age-matched peers.



## Logic

### Logic

- Our experiment aimed to assess sensitivity to within-category variation in VOT for LI and normal listeners.
- If language impaired listeners are more sensitive to within-category detail than normal, their patterns of lexical activation should be more gradient.
  - Enhanced sensitivity could arise from perceptual problems or general causes, such as heightened activation for lexical competitors (McMurray, Samelson, Lee & Tomblin, 2006, submitted).
- Alternatively LI listeners may show similar sensitivity to VOT, but heightened activation for competitors.



## Methods

### Stimuli

- Auditory stimuli consisted of six 9-step VOT continua ranging from 0-40 ms.
- Both endpoints of each continuum were picturable words:
  - beach/peach* *beak/peak*
  - bail/pail* *bear/pear*
  - bees/peas* *bin/pin*
- Stimuli were constructed from recordings of natural speech as in Coady et al., 2005.
- Six L-initial words and six Sh- initial words were used as fillers along with the critical stimuli.
- Each continuum step repeated 5 times.

### Participants

- 32 Normal and 37 LI adolescents (14 - 20 y.o.)
- Language status assessed with epiSLI criteria of Tomblin, Records and Xhang (1996).

### Predictions

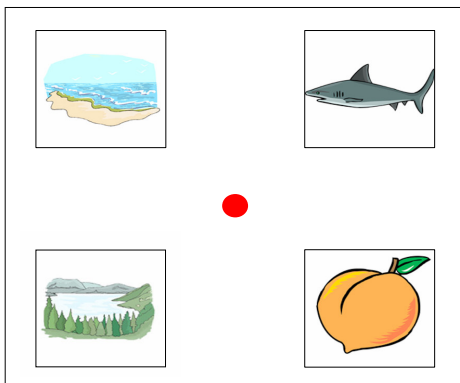
- LI listeners may show more gradient patterns of lexical activation.
- LI listeners may show different levels of activation for lexical competitors.

## Methods

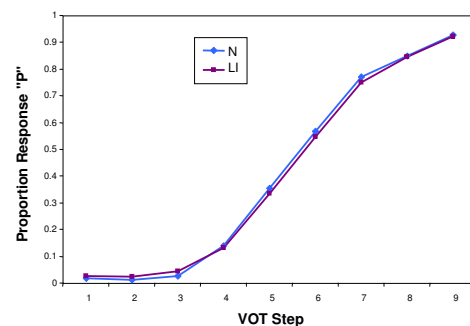
### Procedure

Used visual world paradigm of McMurray et al. (2002).

- On each trial participants were presented with four pictures on a computer screen (e.g. beach, peach, lake, and shark)
- Participants heard an auditory stimulus and selected the corresponding picture.
  - Auditory stimuli consisted of VOT continuum (e.g. *bear/pear*).
- Eye-movements were monitored during the task.
- Fixations were used as a measure of strength of lexical activation for different items.



## Results



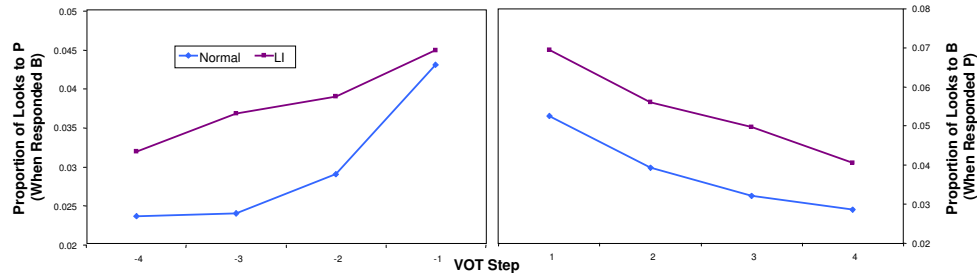
### Mouse-click analysis

- Both LI and normal participants showed standard categorization functions.
- No group difference (LI group no more categorical).
- Replicates Coady et al. (2007) results, again with natural speech.

# Results

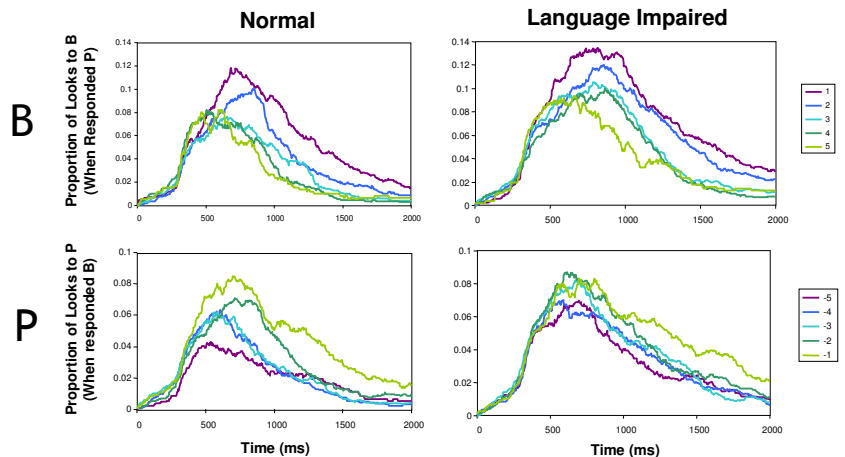
## Data processing

- Logistic functions fit to each participant's data to obtain individual category boundaries.
- Only trials for which participants clicked on correct targets (according to their boundaries) were used during analysis.
  - Changes in looks to the competitor (the item on the other end of the continuum) must be due to **within-category** variation.
- Category boundaries also used to re-compute VOT for each person
  - Step was relative to individual category boundary rather than group mean.
  - More **conservative** measure of within category sensitivity: boundary variation can't contribute to gradiency.



## Eye-movement analysis

- LI group showed a higher activation for the competitor
  - P side ( $F(1,61)=7.17, p < .01$ )
  - B side was marginal ( $F(1,67)=3.63, p < .06$ )
- Proportion of fixations to the lexical competitor showed sensitivity to within-category variations in VOT.
  - B side ( $F(1,67)=45.62, p < .001$ )
  - P side ( $F(1,61)=48.10, p < .001$ )
  - As VOT approached the boundary, more competitor fixations.
- This gradient effect of VOT did not interact with language status on either side of the boundary ( $p > .1$ ).
- The analysis was repeated without the two steps closest to the boundary (-1 and 1) to be conservative.
  - The gradient effect was still found on both sides of the continuum.
    - B side ( $F(1,67)=6.89, p < .01$ )
    - P side ( $F(1,61)=14.49, p < .001$ )
    - Effect is not solely due to enhanced sensitivity near the boundary.



## Conclusions

- For both normal and LI listeners, activation for competitors was systematically related to VOT, - even within the category.
- Language impaired participants showed more activation for the competitor overall.
- Gradient sensitivity to VOT was not affected by language status.
- If LI listeners are insensitive to fine-grained detail (the Tallal hypothesis), they should not have shown such gradient sensitivity.
- These results suggest that inhibition of competitors on a lexical level, rather than differences in perceptual sensitivity, may underlie perceptual problems for listeners with language impairments.

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