

# Gradient effects of within-category VOT differences on lexical activation as measured by eye fixations

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## Introduction

Speech perception is rife with examples of temporal ambiguity. Consider, a word like

**p ob** in which the first consonant is ambiguous between p and b. This ambiguity could be resolved by the length of the vowel, "o" (indicating speaking rate or stress), the fact that "bob" is a word (sort of) and "pob" is not, or other later-occurring factors like phonology or coarticulation.

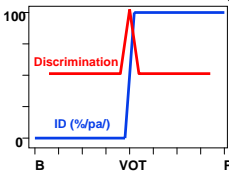
Ambiguity resolution and temporal integration of information would be more efficient if

- the system does not completely commit to a single alternative at any given time
- if competitors remain active to degree with which they match the input

Thus, to effectively resolve phonetic/lexical temporal ambiguities, the perceptual system must keep track of fine grained acoustic details.

## Categorical Perception

The extensive literature on categorical perception suggests that listeners do not have access to subphonemic variation: listeners exhibit a consistently sharp category boundary for consonant identification and poor discrimination within a category.



However, evidence to the contrary has come from a variety of other tasks: reaction time (Pisoni & Tash, 1974), goodness judgments (Miller, 2000), and discrimination training (Samuel, 1977). Still, these tasks have only shown this sub-phonemic sensitivity using off-line metalinguistic tasks.

### Questions:

- Do these differences effect lexical access?
- What is the nature of the effect?
- Perhaps a more sensitive measure?

## Experiment 1: Ba/Pa

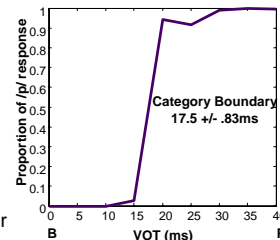
**Purpose:** to explore possible gradient effects using "traditional" stimuli/task with a more sensitive measure (eye-tracking).

### Methods:

- 9-step /ba/ - /pa/ VOT continuum (0-40ms)
- Identification indicated by mouse click.
- Eye movements monitored at 250 Hz.
- 17 Subjects

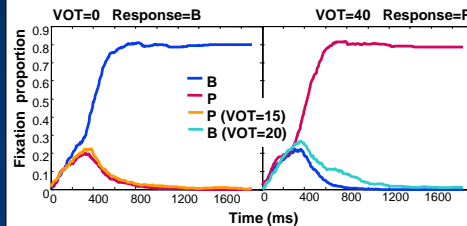
### Identification Results

- Near perfect categorization
- Stimuli are comparable to previous research.



### Eye Movement Results

- Remove trials for which subject responded with infrequent alternative (e.g. "b" for a 40ms VOT).



- Looks to competitor even for trials in which response was the target.
- Small differences in competitor activation near the category boundary.

## Lexical effects

However, we are really interested in **lexical** activation...

**2AFC phoneme identity** tasks purport to measure phoneme (not lexical) activation and require metalinguistic judgments. They may **underestimate** sensitivity to subphonemic variation.

## Evidence for Lexical effects

Andruski, Blumstein & Burton (1994)

- Auditory Semantic Priming
- Significantly less semantic priming for t-words near the VOT category-boundary compared to identical words further from it.
- Effect occurred with 50ms, but not 250ms ISI

This result is important, but does not provide evidence for gradiency or details about temporal dynamics.

## Experiment 2: Words

- Six 9-step /b/ - /p/ VOT continuum (0-40ms)

Bear/Pear	Beach/Peach
Butter/Putter	Bale/Pale
Bump/Pump	Bomb/Palm

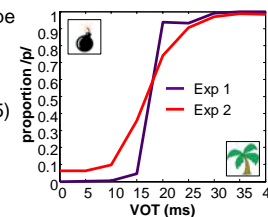
- 12 /l/- and /sh/- Filler items

Leaf	Ladder	Ship
Lip	Lock	Shark
Lamp	Shirt	Sheep
Leg	Shoe	Shell

- Identification indicated by mouse click on *picture*
- Eye movements monitored at 250 Hz
- 17 Subjects

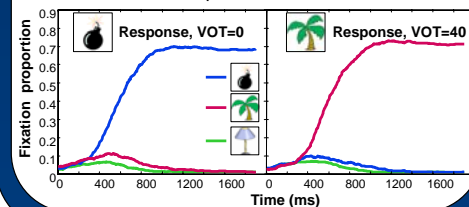
### Mouse Identification Results

- Much steeper slope for Experiment 2
- Identical category boundaries (BP= 17.5 Words=17.25)
- Stimuli fit classic pattern.
- Effect of task?



### Eye Movement Results

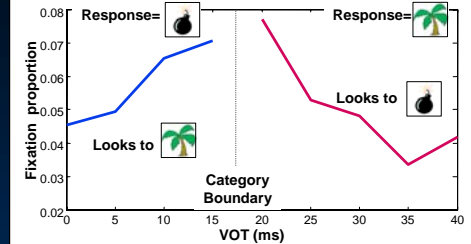
- More looks to competitor than unrelated items.



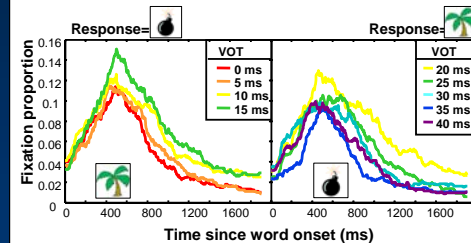
## Experiment 2: Words

### Eye Movement Results (filtered by response)

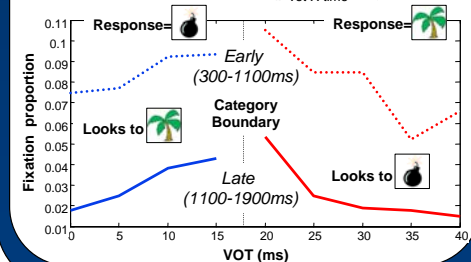
- Clear gradient effect of VOT on looks to the competitor ( $p_b=.023$ ,  $p_p=.002$ )
- Effect remains for unambiguous VOTs (0-10ms:  $p_b=.017$ ; 25-40ms:  $p_p=.002$ ).



- **Duration**, not amplitude, of competitor activation increases with VOT.



- Effect holds after 1100ms ( $p_{\text{VOT} \times \text{time}} > .1$ )



## Conclusions

Steeper slope for 2AFC phoneme ID tasks. Such tasks may underestimate gradient sensitivity.

VOT exerts a **gradient effect** of lexical activation in word task.

- Effect holds for unambiguous stimuli
- Effect is long-lasting
- Affects duration, not amplitude, of activation

Lexical activation reflects subphonemic variation in a way that could be meaningful for resolving **temporal ambiguity** and **integrating information** over time.