Attention and salience in lexically-guided perceptual learning

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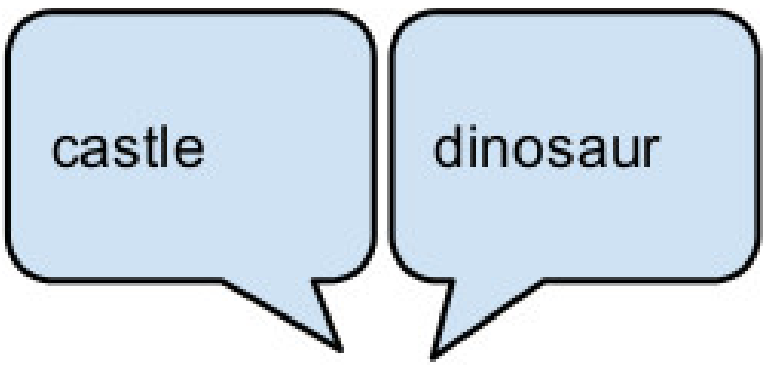
PhD Defense

Perceptual constancy

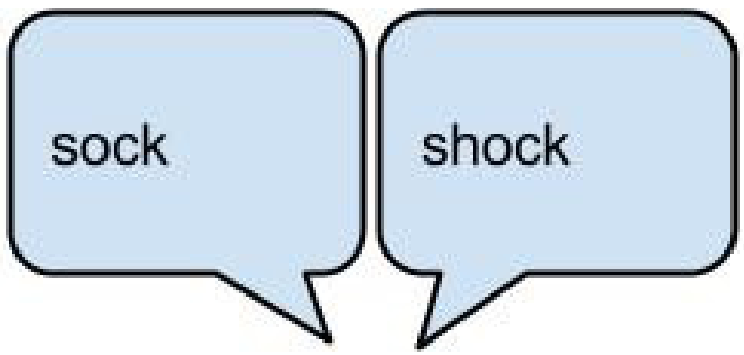
Despite variation, listeners can interpret variable productions as a single word type

Shankweiler et al. (1977); Kuhl (1979); Sumner and Kataoka (2013)

Perceptual learning

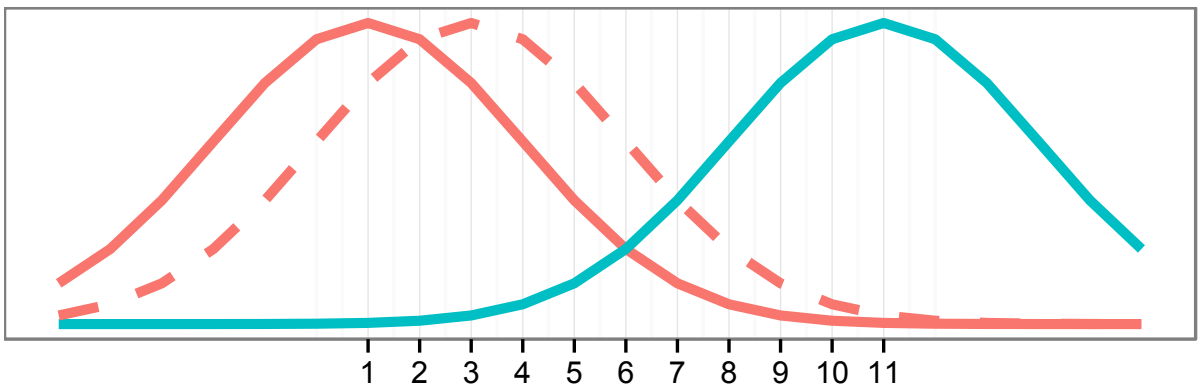


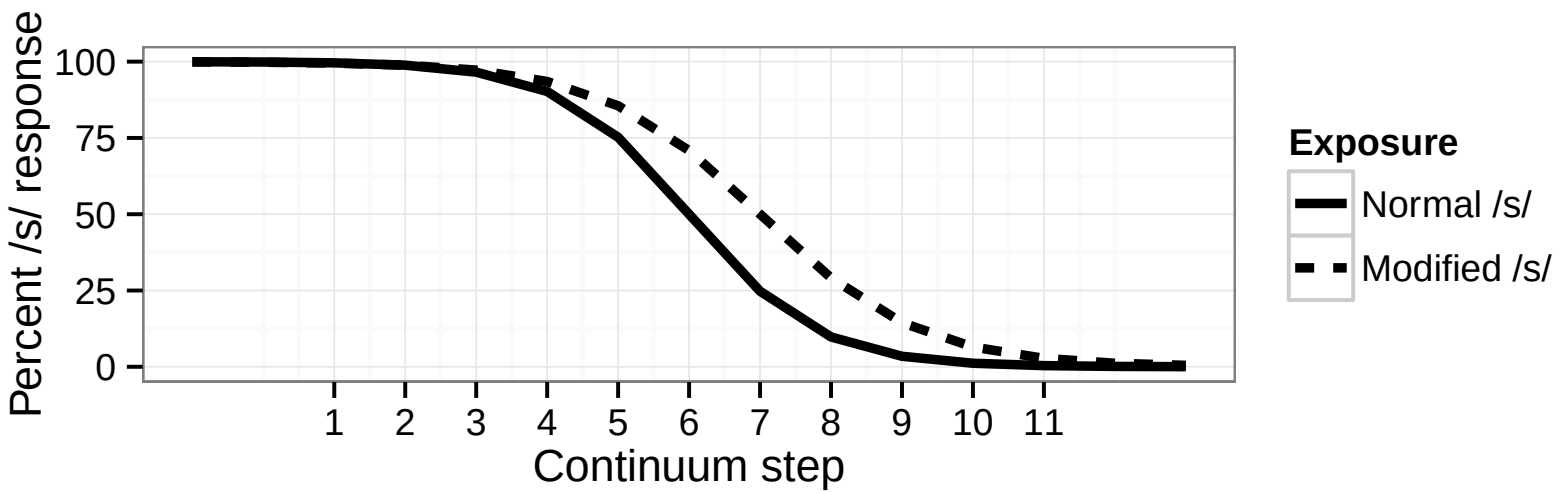
Exposure



Categorization

Categorization





Sources of variation

Example: /s/

SPEAKER

- Indexical
  - Accent
  - Gender

LISTENER

- Indexical
  - Accent
  - Perceived accent
  - Perceived gender

Strand and Johnson (1996); Li et al. (2011); Kraljic and Samuel (2005)

Sources of variation

Example: /s/

SPEAKER

- Contextual
  - Speaking rate
  - Coarticulation (/stɹ/)
  - Word position
  - Predictability

LISTENER

- Contextual
  - Speaking rate
  - Coarticulation (/stɹ/)
  - Word position
  - Predictability

Lieberman (1963); Kraljic et al. (2008); Clopper and Pierrehumbert (2008); Pitt and Szostak (2012)

Sources of variation

Example: /s/

SPEAKER

- Attention

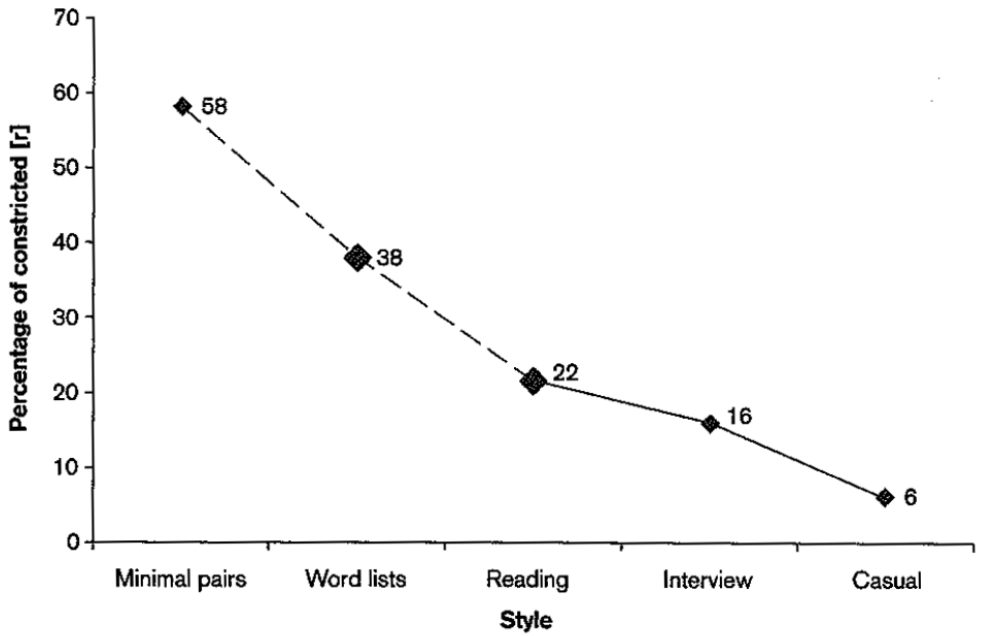


Figure 3.2 Occurrence of constricted [r] in New York City English in five speech styles. (Dashed line indicates the qualitatively different activities involving the use of unconnected speech.) (Source, Labov 1966: 221.)

LISTENER

- Attention
  - Comprehension
  - Perception

Labov (1997); Pitt and Szostak (2012)

Real world example

- Students taught by a professor with non-native accent
  - Some students will try to comprehend the lecture
  - Some students will get distracted by pronunciation
  - Some students will daydream
  - Do they all perceptually learn?

Research question

How do changes to a listener's attention in exposure affect perceptual learning in future categorization?

Interaction of variation

Example: /s/

Speaker

- Contextual
  - Speaking rate
  - Coarticulation (/stɹ/)
  - **Word position**
  - **Predictability**
- Attention

Salience

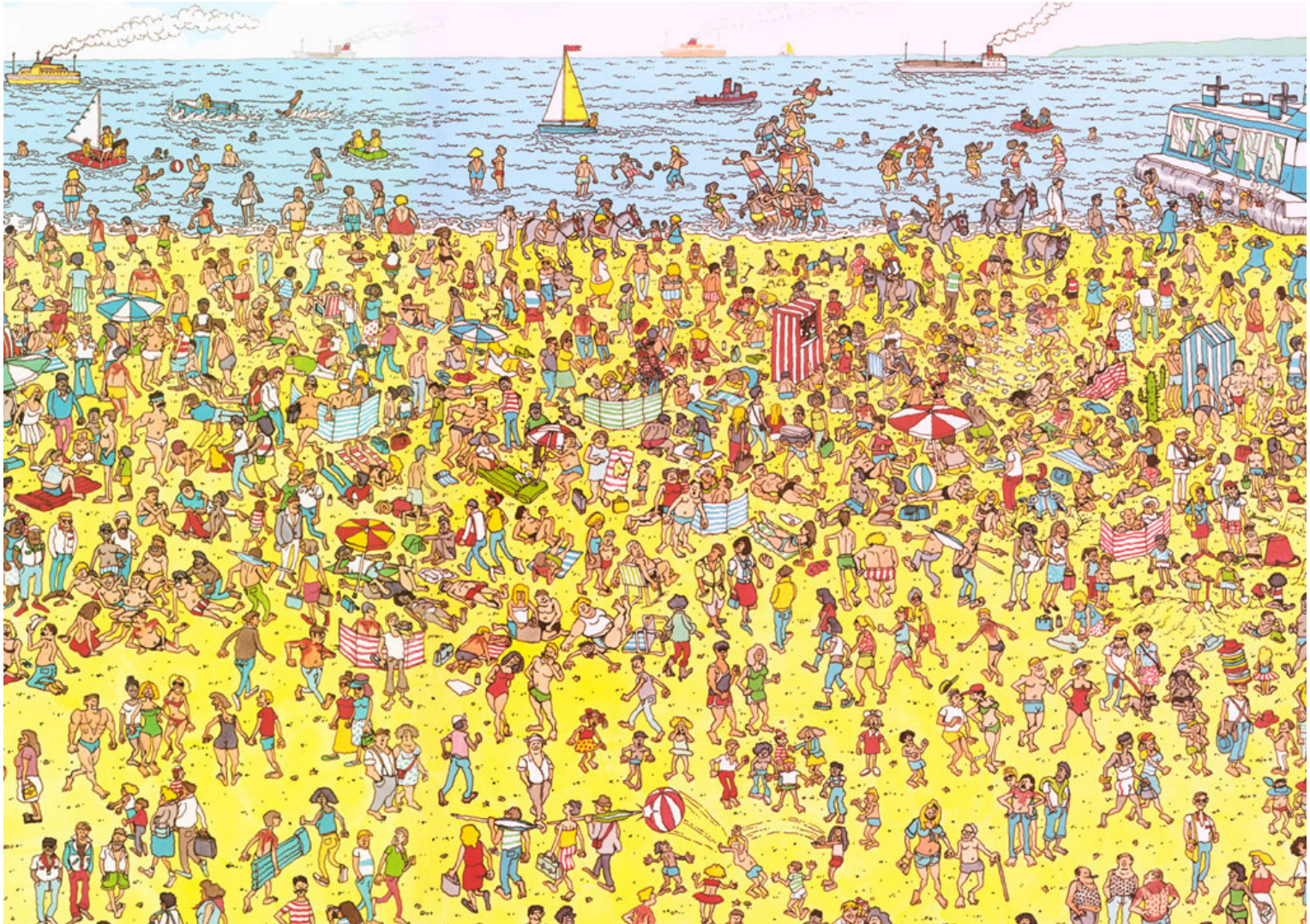
Listener

- Contextual
  - Speaking rate
  - Coarticulation (/stɹ/)
  - Word position
  - Predictability
- **Attention**
  - Comprehension
  - Perception

Outline

Attentional sets

Strategies to parse our perceptual experience



Attentional sets

Comprehension-oriented

- Focus on comprehending meaning
- Real world example:
  - Students in lecture
  - Primary focus is comprehending the professor (we hope)

Pitt and Szostak (2012)

Attentional sets

Perception-oriented

- Focus on perceiving a specific pronunciation
- Real world example:
  - Students in lecture
  - Professor with a non-native accent
  - Primary focus might shift from comprehension

Pitt and Szostak (2012)

Attentional sets in perceptual learning

- Comprehension-oriented tasks
  - Lexical decision
  - Sentence transcription
- Perception-oriented tasks
  - Psychophysical perceptual learning
  - Audio-visual lipreading (nonwords)

Ahissar and Hochstein (1993); Norris et al. (2003); Vroomen et al. (2007); Bradlow and Bent (2008); Reinisch et al. (2014)

Generalization in perceptual learning

Comprehension-oriented tasks generalize

- New words or nonwords
- (Sometimes) new voices

Perception-oriented tasks do not generalize as readily

- Exposure specificity

Ahissar and Hochstein (1993); Norris et al. (2003); Kraljic and Samuel (2005); Bradlow and Bent (2008); Pitt and Szostak (2012); Reinisch et al. (2013)

Hypothesis

Comprehension-oriented attentional sets allow for greater generalization than perception-oriented attentional sets.

Experimental paradigm

Comprehension-oriented tasks

- Lexical decision
- Word identification in sentences

Manipulations to promote perception-oriented attentional sets

- Instructions
- Salience
  - Unpredictability or low expectations
  - Increase the likelihood of listeners noticing modification
  - Assumption: similar to increasing the number of /s/ trials relative to filler trials

Explicit instructions

- “This speaker’s ‘s’ sounds are ambiguous”
- “Please listen carefully to ensure you make the correct choice”
- Promote perception-oriented attentional set

Pitt and Szostak (2012)

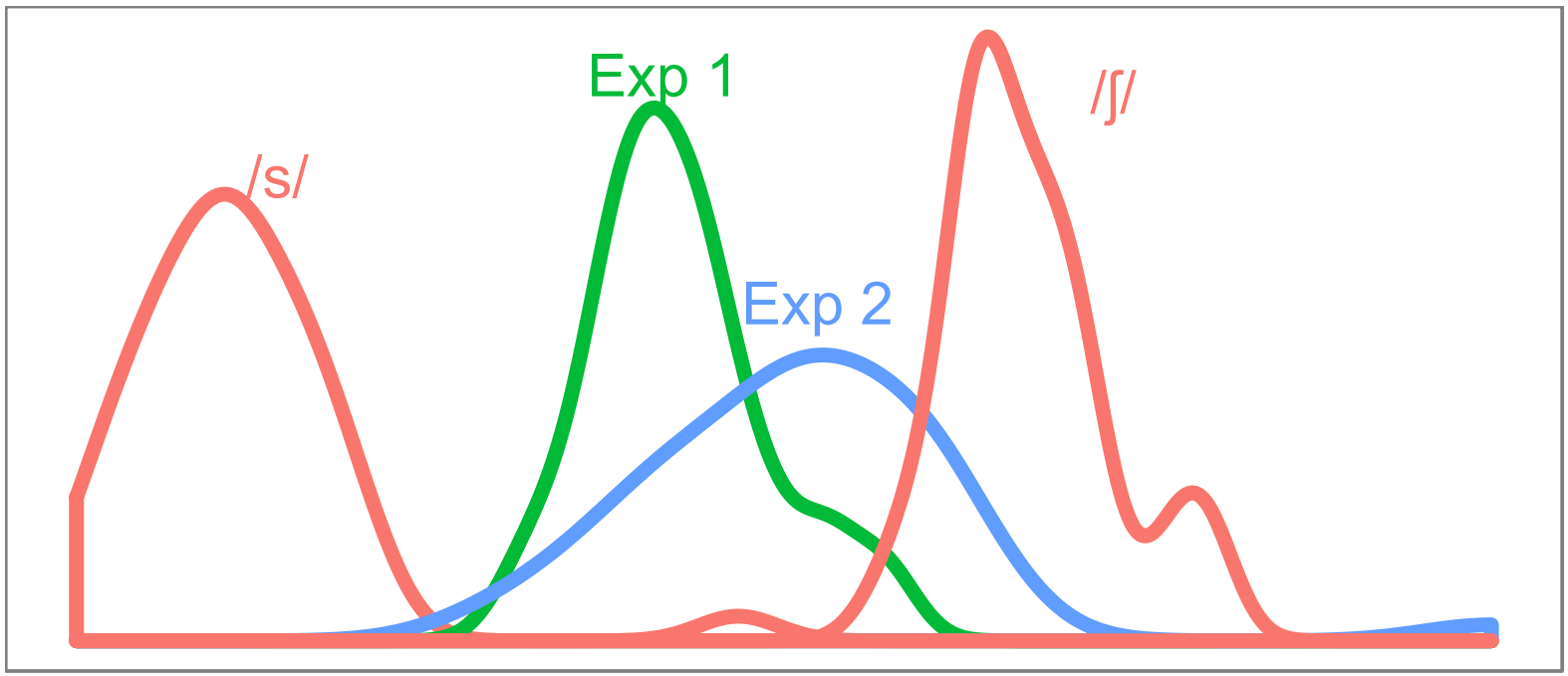
Salience - Word position

- Listeners are more tolerant of variation later in the word
- Word-initial modified /s/ should be more salient
- Examples
  - Word-initial: *submarine*
  - Word-medial: *whistle*

Pitt and Szostak (2012)

Salience - Category typicality

- Productions farther from the mean of a category are more salient



Experiments 1 and 2

Experiment 1

- Lexical decision exposure task
- 94 native English participants
- Across subject factors
  - Instructions
  - Position of modified /s/ in words (Word-initial vs word-medial)
- 50% word response rate in a pre-test (n = 20)

Experiment 2

- Same design and materials as Experiment 1
- 96 native English participants
- 30% word reponse rate in the pre-test (more atypical /s/)

Sample trials

Exposure

- Hear: whistle (Experiment 1) (Experiment 2)
- Hear: submarine (Experiment 1) (Experiment 2)
- Word or nonword?

Categorization

- Hear: sock-shock (continuum), sin-shin, sack-shack, sigh-shy
- Sock or shock? Sin or shin? etc.

Experiment 1 and 2 predictions

Possible categorization outcomes:

- Equal perceptual learning effects across all conditions
- Less perceptual learning when perception-oriented attentional sets are promoted
  - Primary hypothesis
- Perceptual learning effects stronger in Word-initial exposure condition
  - More similar to categorization items

Experiment 1 - Word-initial exposure

Ambiguous /s/

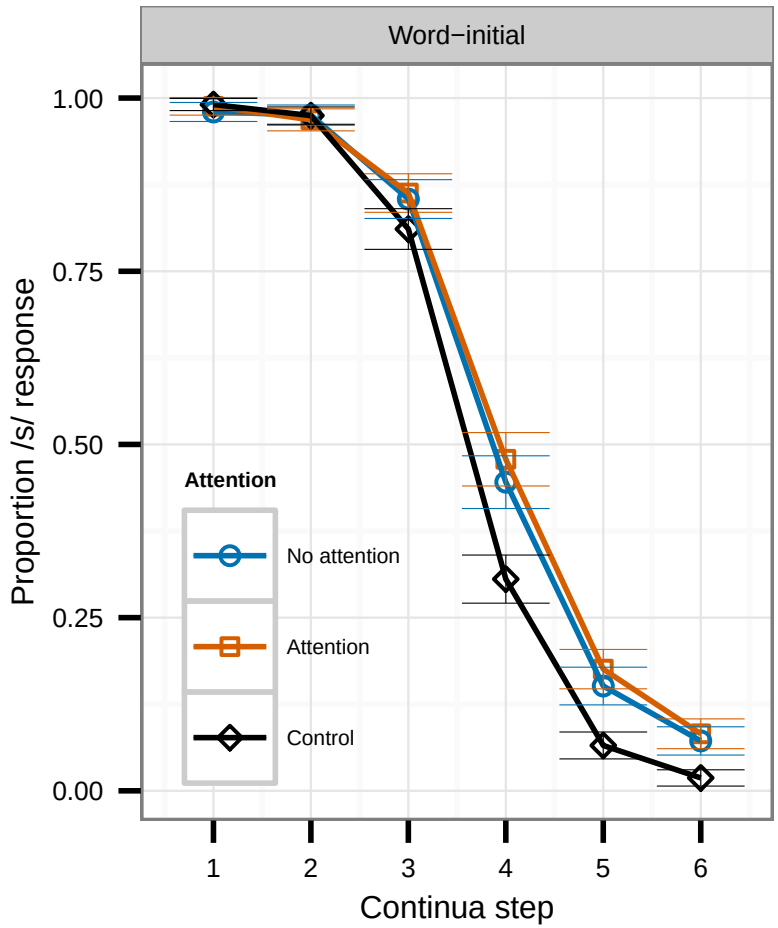
- 50% between /s/ and /ʃ/

Attention

- No /s/-oriented instructions
- Told /s/ would be ambiguous

Position of /s/

- *Word initial*
- Word medial



Experiment 1 - Word-medial exposure

Ambiguous /s/

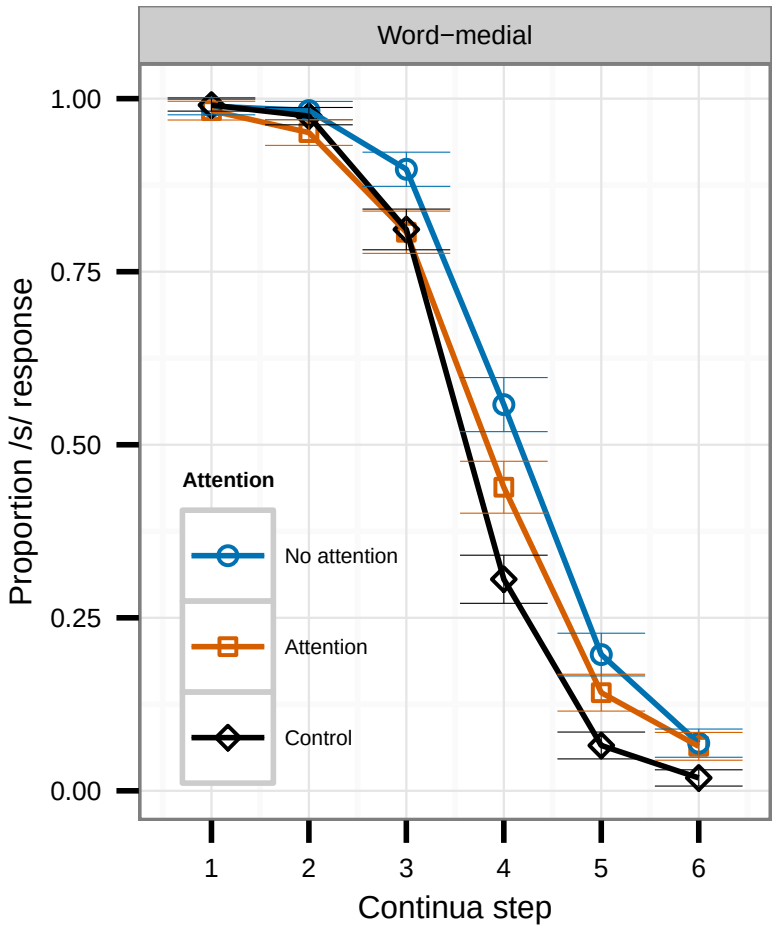
- 50% between /s/ and /ʃ/

Attention

- No /s/-oriented instructions
- Told /s/ would be ambiguous

Position of /s/

- Word initial
- *Word medial*



Experiment 2 - Word-initial exposure

Ambiguous /s/

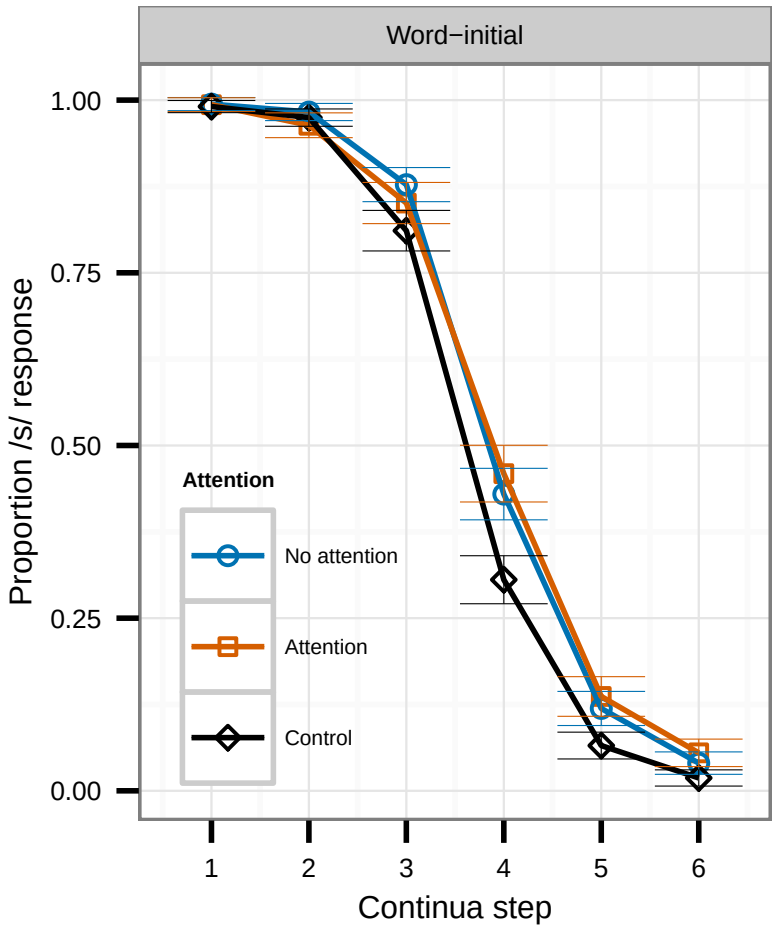
- More like /ʃ/ than /s/

Attention

- No /s/-oriented instructions
- Told /s/ would be ambiguous

Position of /s/

- *Word initial*
- Word medial



Experiment 2 - Word-medial exposure

Ambiguous /s/

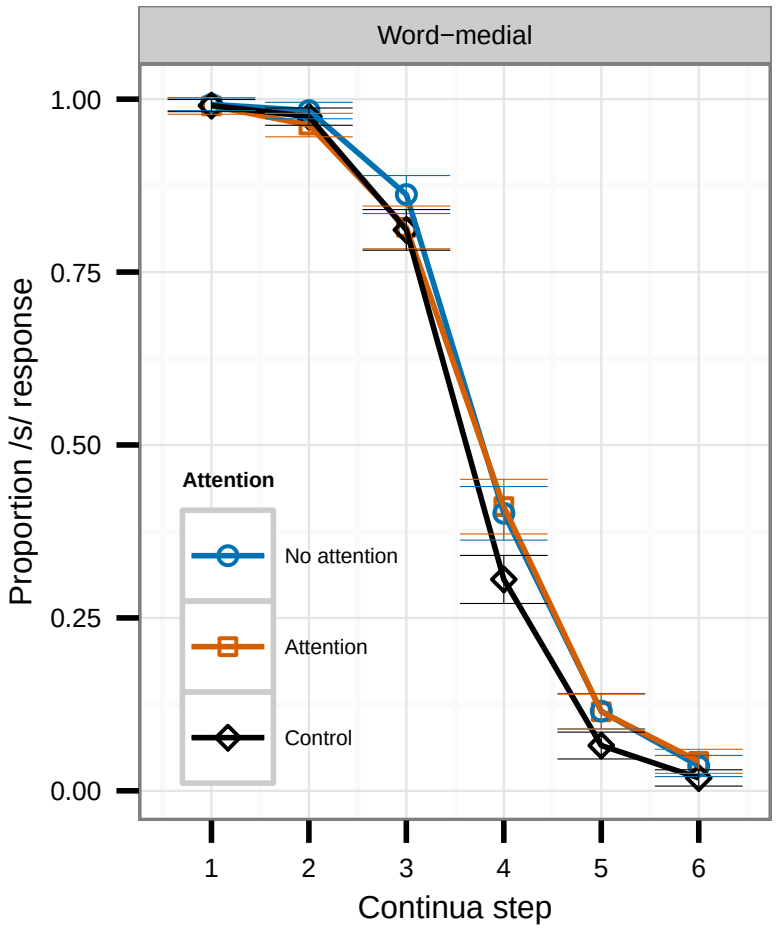
- More like /ʃ/ than /s/

Attention

- No /s/-oriented instructions
- Told /s/ would be ambiguous

Position of /s/

- Word initial
- *Word medial*



Summary

- Results align with attentional sets
- Conditions promoting a perception-oriented attentional set
  - Had smaller perceptual learning effects
  - Still showed perceptual learning
  - Did not differ from one another
- Fine-grained similarity did not appear to play a role
  - Word-medial exposure had the largest effect

Further promoting comprehension

- Lexical decision is comprehension-oriented
  - Word recognition
- Experiment 3 uses words in sentences
  - Attempt to further promote comprehension

Exposure task

- Predictable: The traffic cop alerted the driver by blowing her whistle (Audio)
- Unpredictable: The boy ran away when he heard the whistle(Audio)

Salience - Semantic predictability

- Listeners are more tolerant of acoustic reduction or noise in predictable sentences
- Modified /s/ should be more salient in unpredictable words
- Examples
  - Predictable: The cow gave birth to the calf.
  - Unpredictable: She is glad Jane called about the calf.

Lieberman (1963); Kalikow et al. (1977); Scarborough (2010)

Experiment 3

- 98 native English participants
- Cross-modal word identification
  - Auditory sentences
  - Identification of picture corresponding to final word in sentence
  - Same word-medial modified /s/ stimuli (Experiment 1)
  - Final targets were predictable or unpredictable (pre-test)
- Across subjects
  - Instructions (identical to Experiments 1 and 2)
  - Modified /s/ only in predictable or unpredictable words
- **Same categorization as Experiment 1 and 2**

Experiment 3 categorization predictions

Within sentences:

- Equal perceptual learning
- Bigger perceptual learning effect in predictable exposure
  - Less salient modification
- Smaller perceptual learning effect in predictable exposure
  - Attribution of variation to predictability

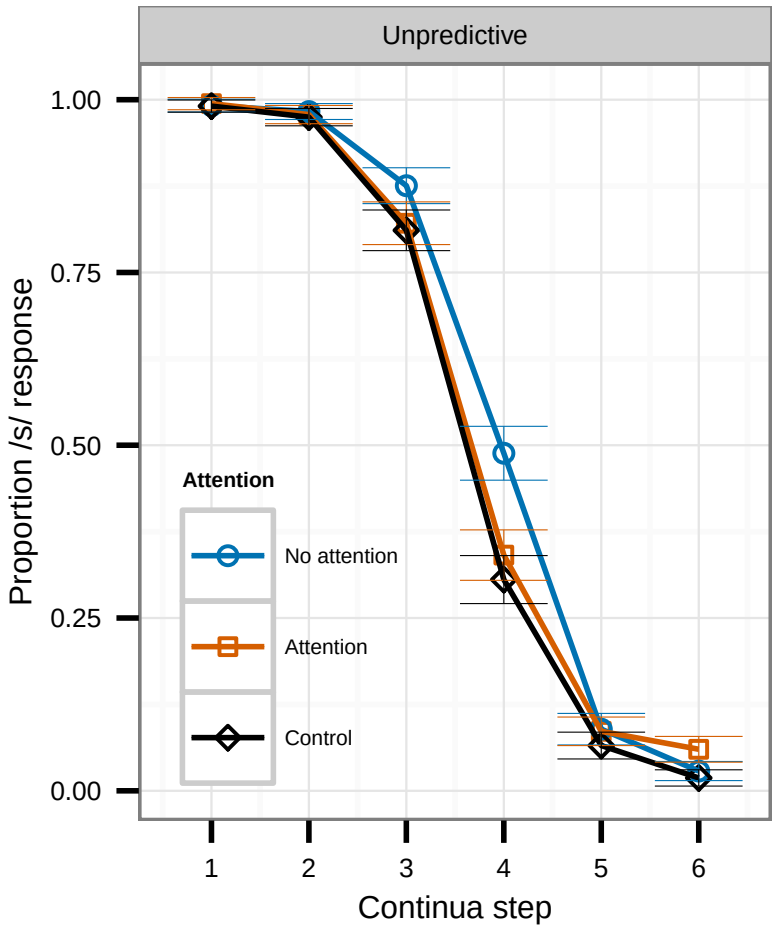
Experiment 3 categorization predictions

Words in isolation vs in sentences

- Equal perceptual learning
- Bigger perceptual learning effect in sentences
  - Comprehension of sentences rather than words
- Smaller perceptual learning effect in sentences
  - Less speaker attention in read sentences

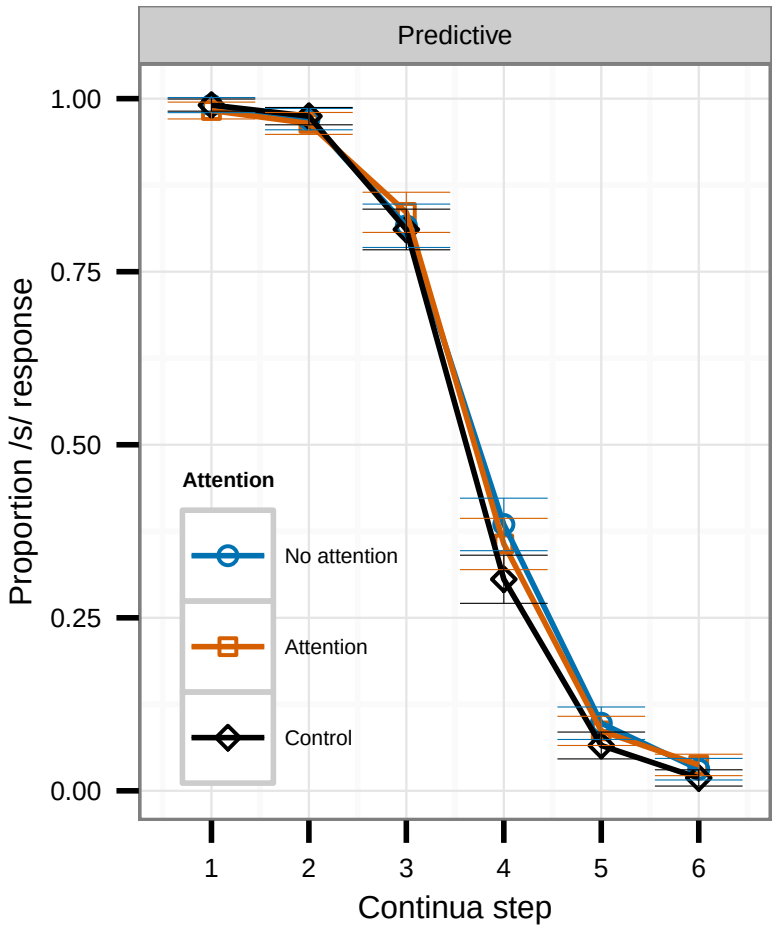
Experiment 3 - Unpredictable exposure

- **Ambiguous /s/**
  - Halfway between /s/ and /ʃ/
  - In sentences
- **Attention**
  - No /s/-oriented instructions
  - Told /s/ would be ambiguous
- **Predictability of final /s/ words**
  - *Unpredictable*
  - Predictable

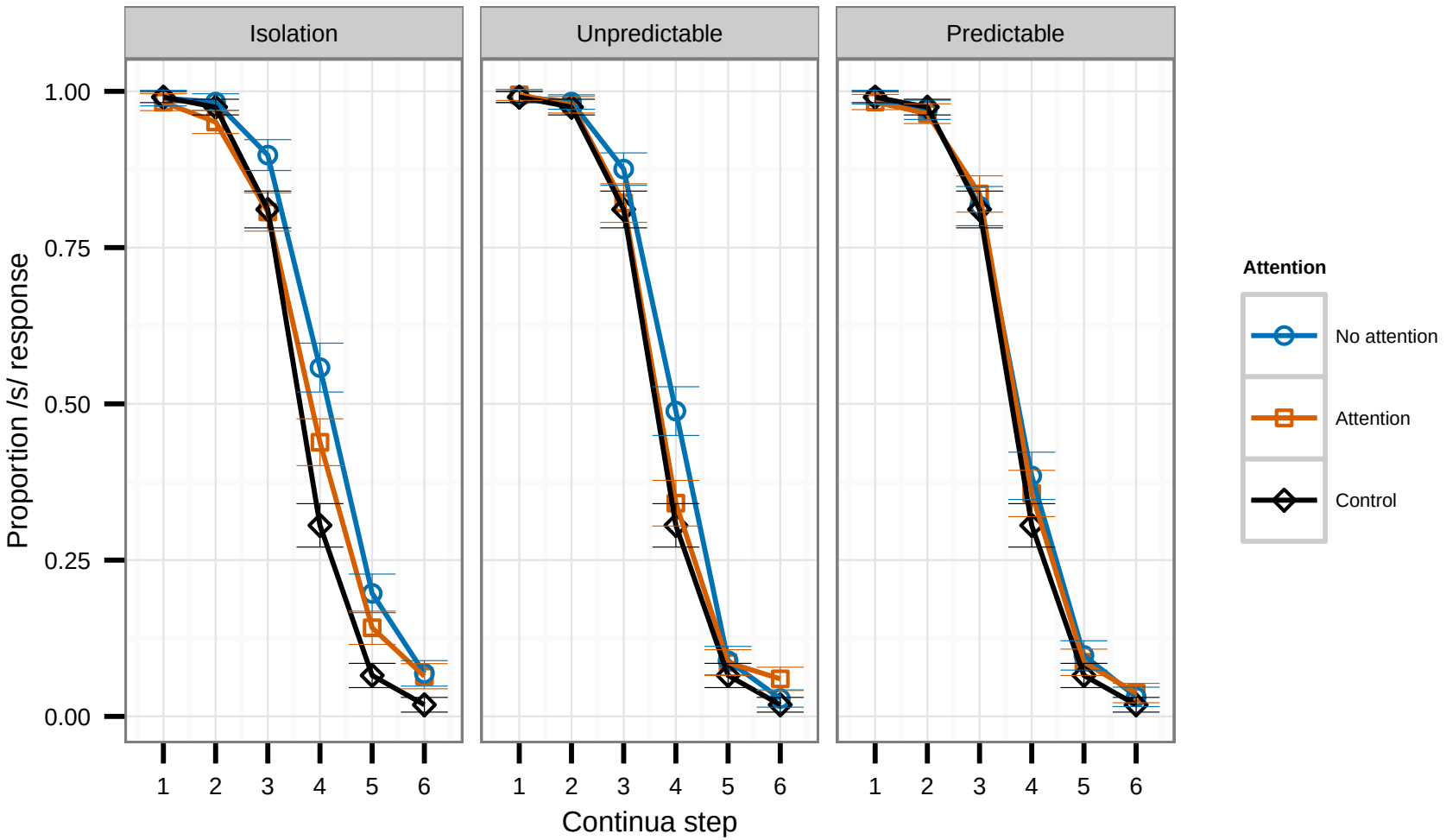


Experiment 3 - Predictable exposure

- **Ambiguous /s/**
  - Halfway between /s/ and /ʃ/
  - In sentences
- **Attention**
  - No /s/-oriented instructions
  - Told /s/ would be ambiguous
- **Predictability of final /s/ words**
  - Unpredictable
  - *Predictable*



Isolation vs Sentences



Summary

- Unpredictable exposure showed a similar pattern to words in isolation
- Predictable exposure showed no perceptual learning effect
  - Similar to studies using a coarticulation context (/stɹ/)
  - Predictable words are typically shorter and less clear
  - Listeners compensate for this predictability
  - Mean durations: Predictable words (0.53 s, SD = 0.06 s), Unpredictable words (0.53 s, SD = 0.07 s)

Clopper and Pierrehumbert (2008); Scarborough (2010); Kraljic et al. (2008)

Discussion

- Attentional sets affected perceptual learning
  - Conditions that did not promote perception-oriented attentional sets showed larger effects
- Predictability was not an effective attentional set manipulation
  - Instead, allowed for attribution of the modified category to predictability

Implications for theoretical models

- Supports hierarchical representations
- Attention to episodic representations or specific pronunciations inhibits learning in abstract categories
- Attention as a gain mechanism is not supported
  - Perception-oriented attentional sets would have larger effects
  - Valency of attention may play a role

Implications - Dialects

- Perceptual learning of salient dialectal features may be inhibited
  - New Zealand/Australian English: *fish and chips*
  - New Zealand/North American English: *Bret* vs *Brit*

Implications - Non-native accents

- Non-native listener / native speaker
  - Perception-oriented attentional set may be the default
- Native listener / non-native speaker
  - Perceptual learning inhibited when attending to pronunciation

Real world example:

- Students attending to the professor's message rather than pronunciation should perceptually adapt more
  - Timecourse of perceptual learning?
  - Size of perceptual learning?

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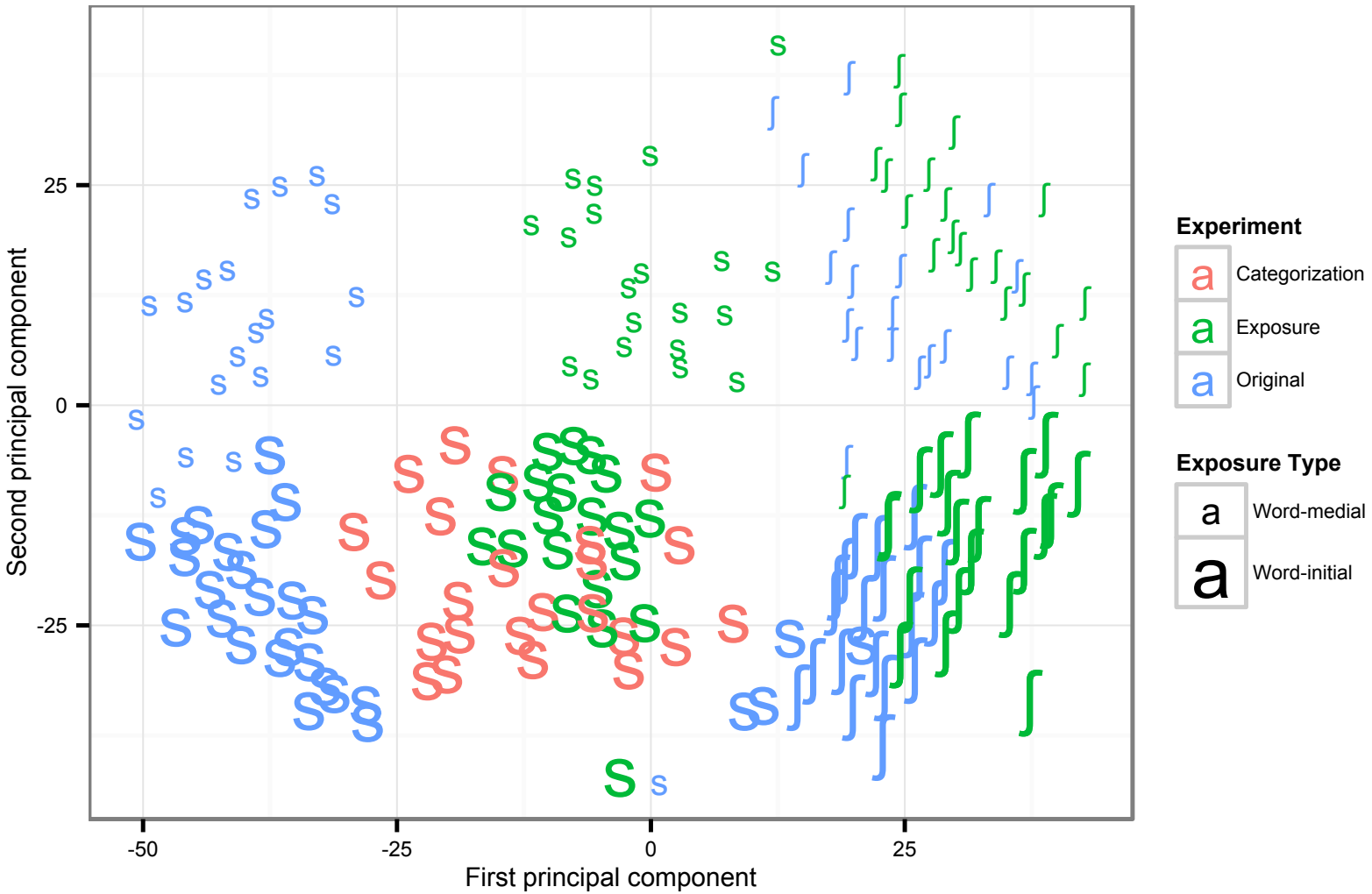
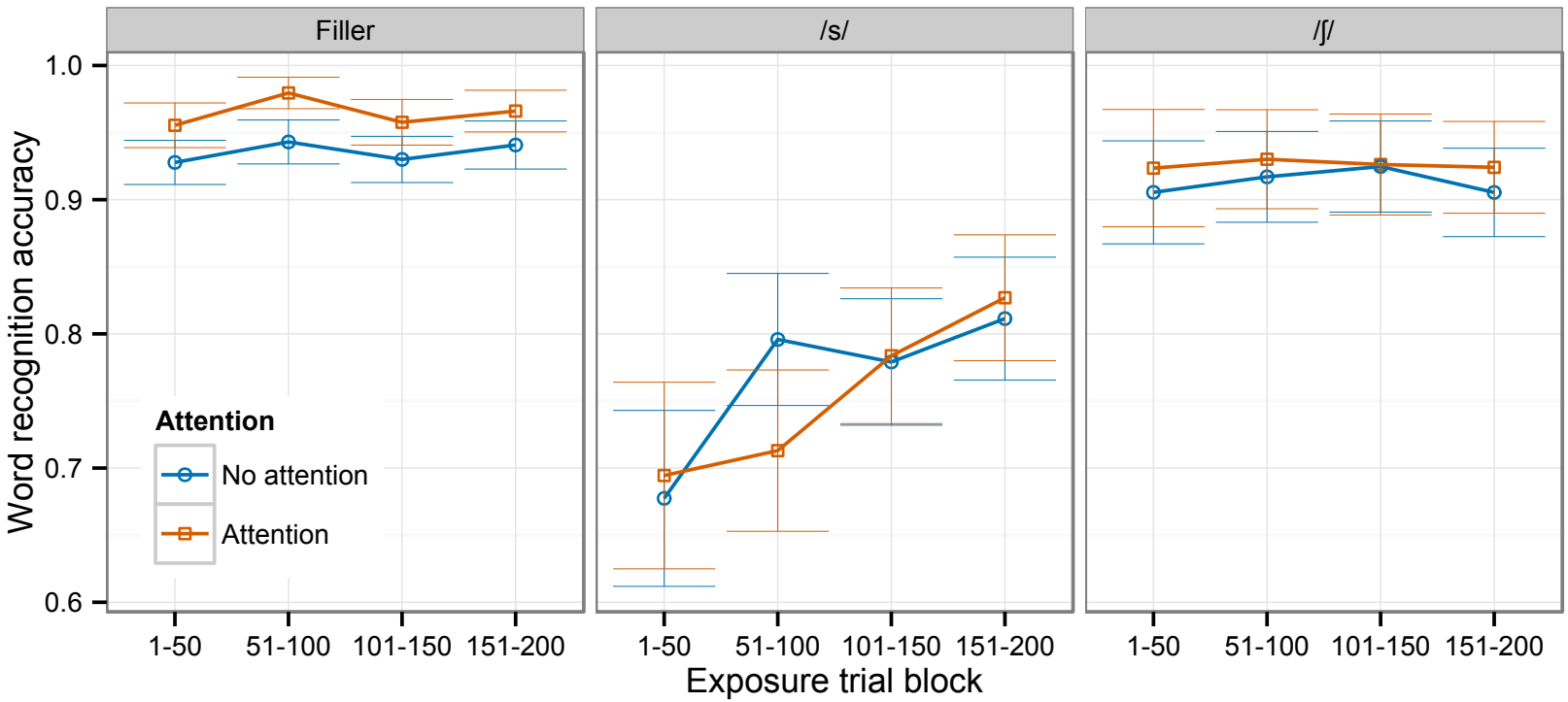
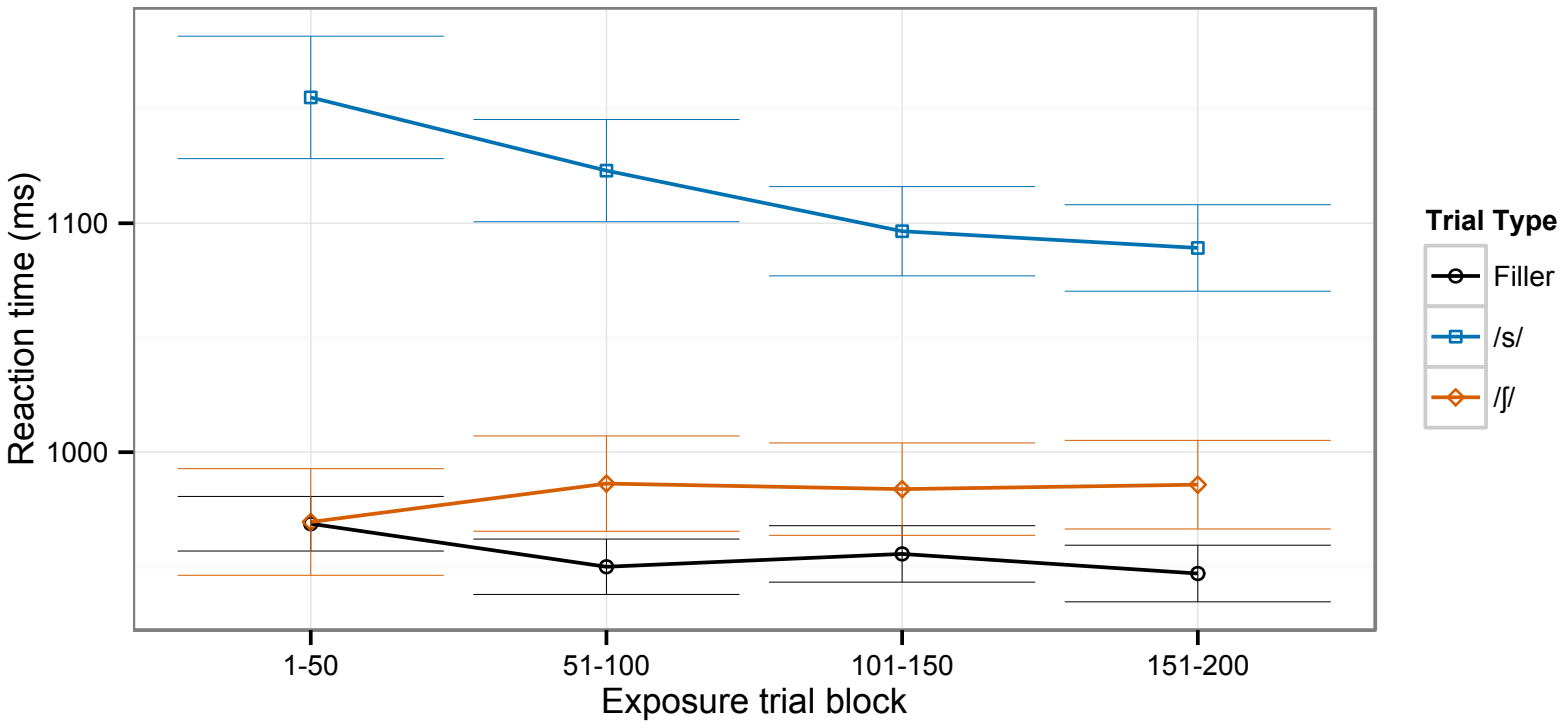
Experiment 1 - Acoustic analysis



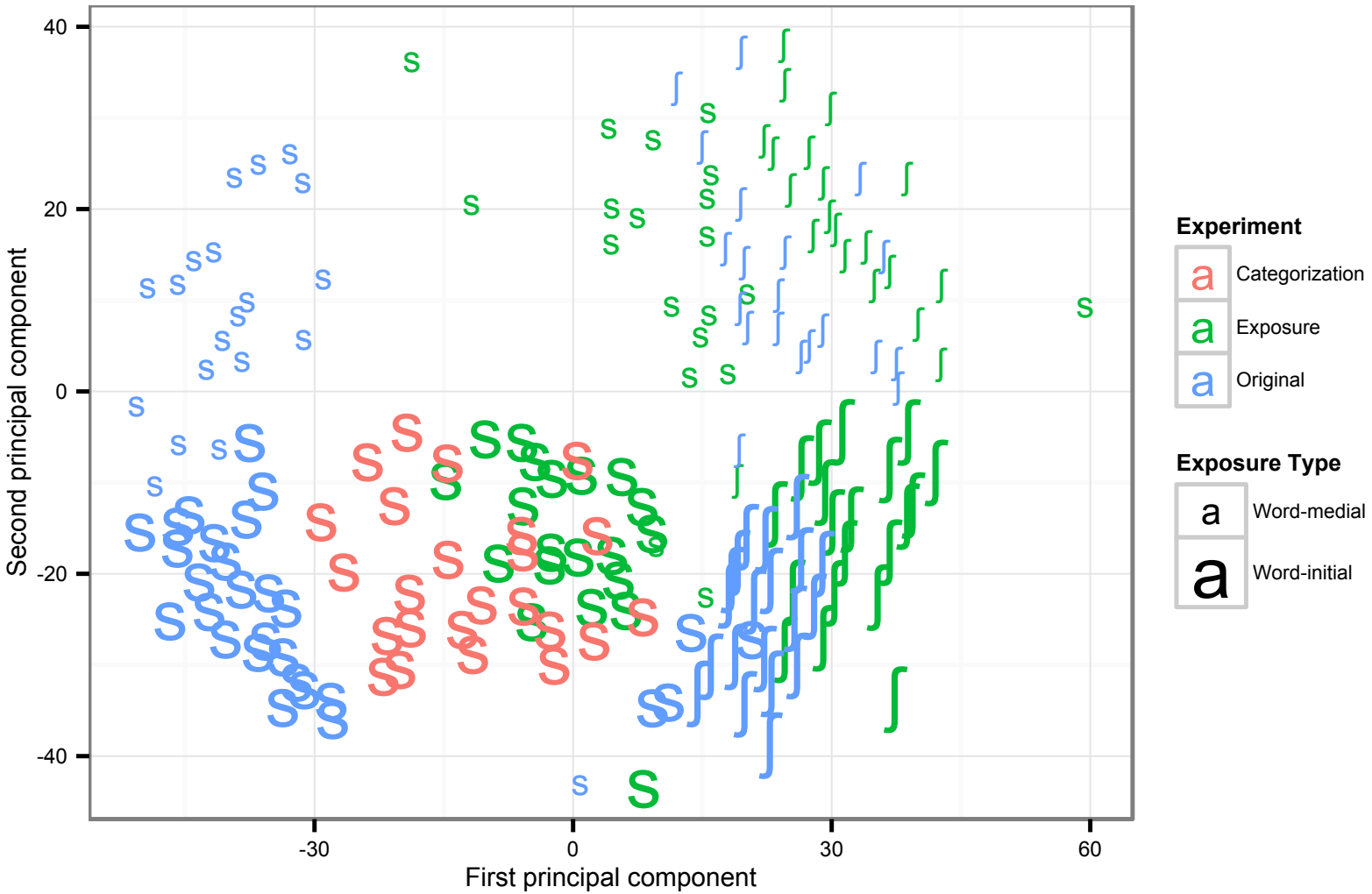
Experiment 1 - Exposure ACC



Experiment 1 - Exposure RT



Experiment 2 - Acoustic analysis



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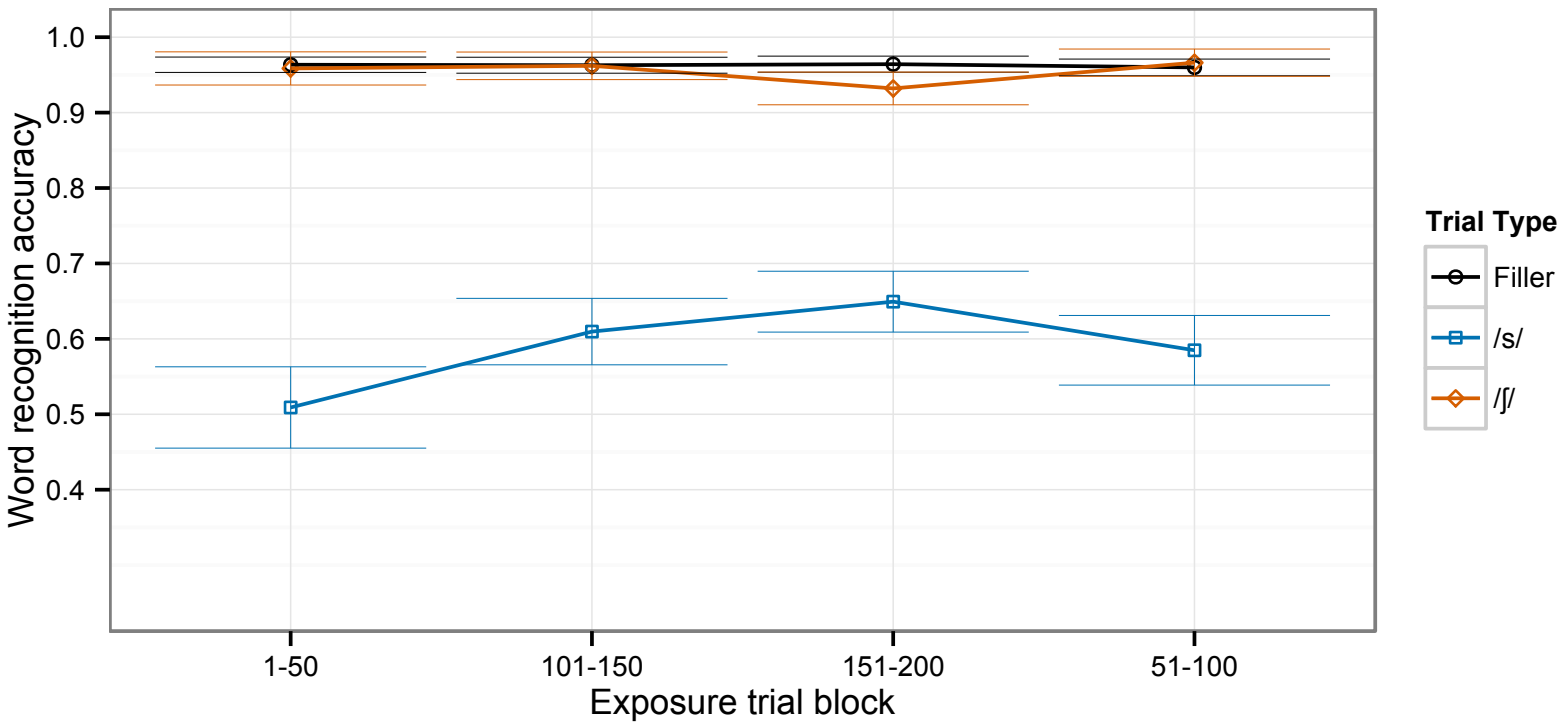

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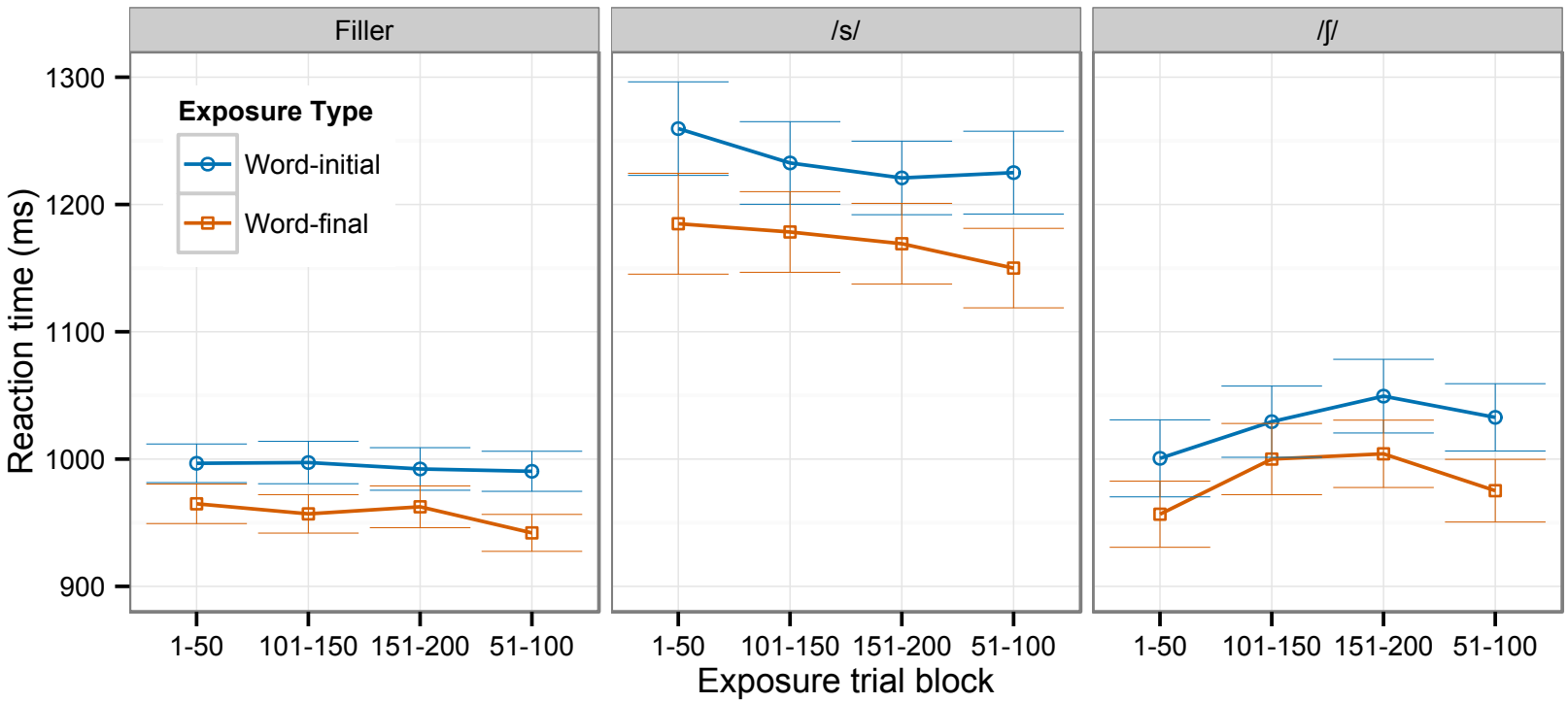
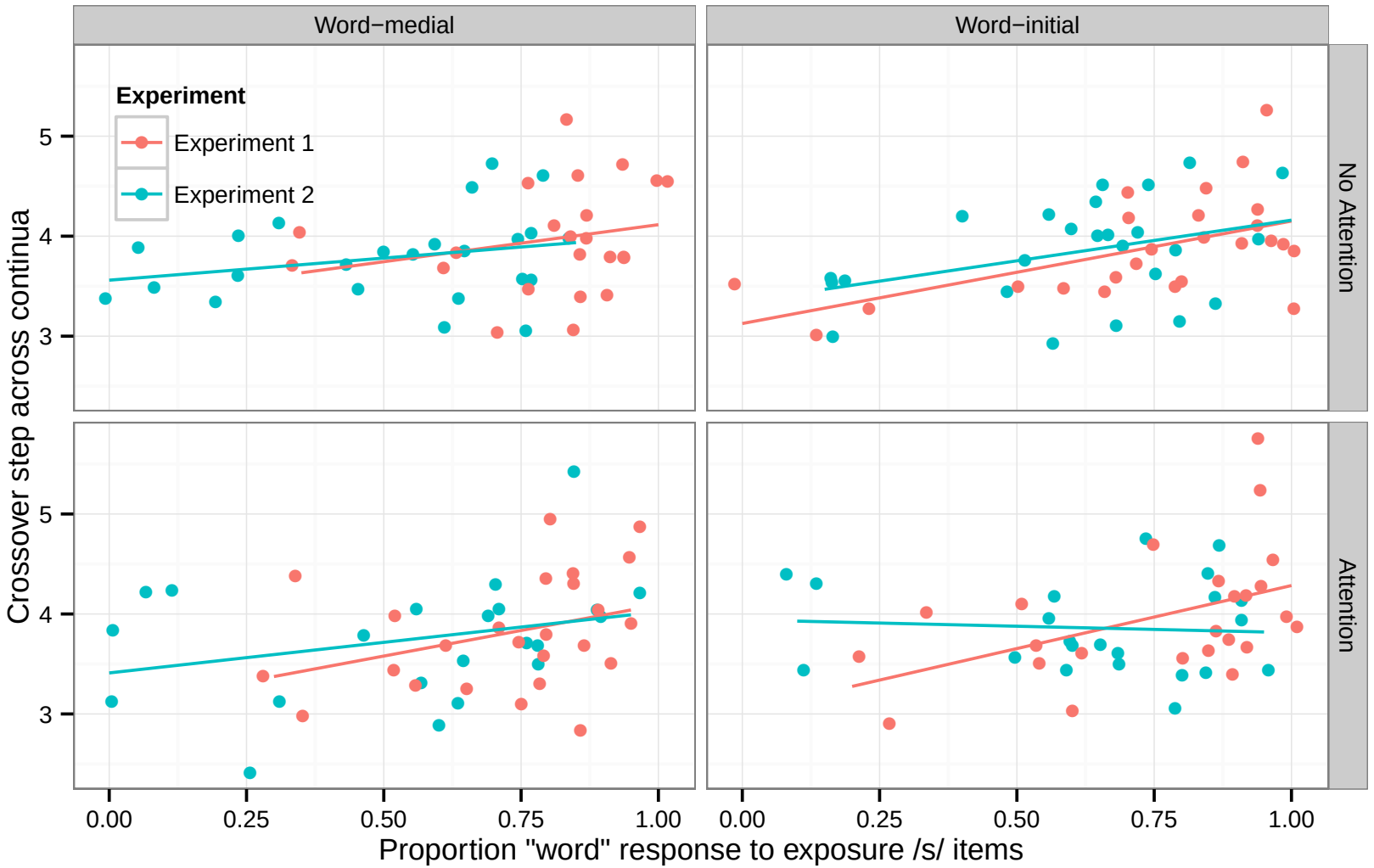
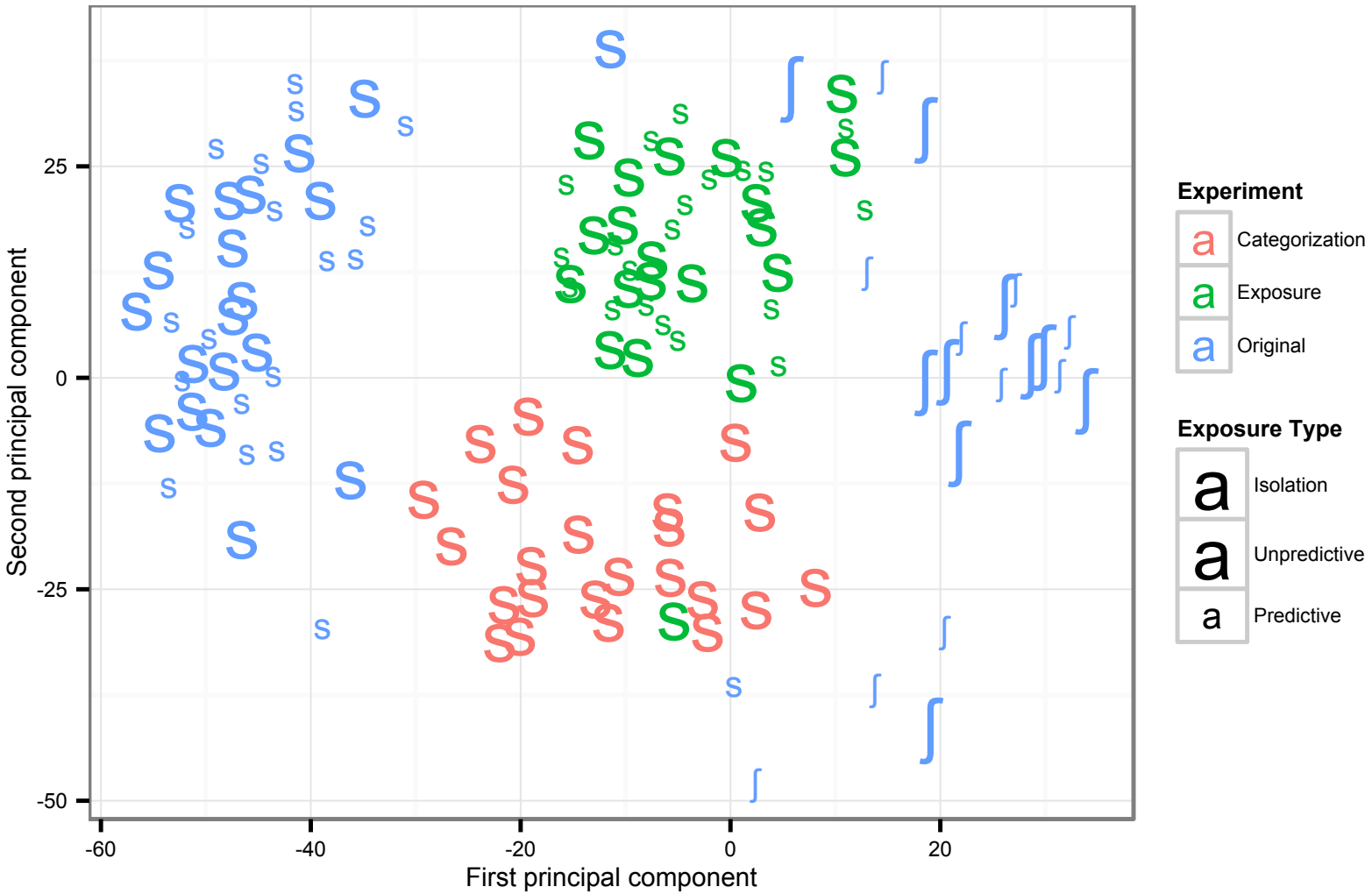


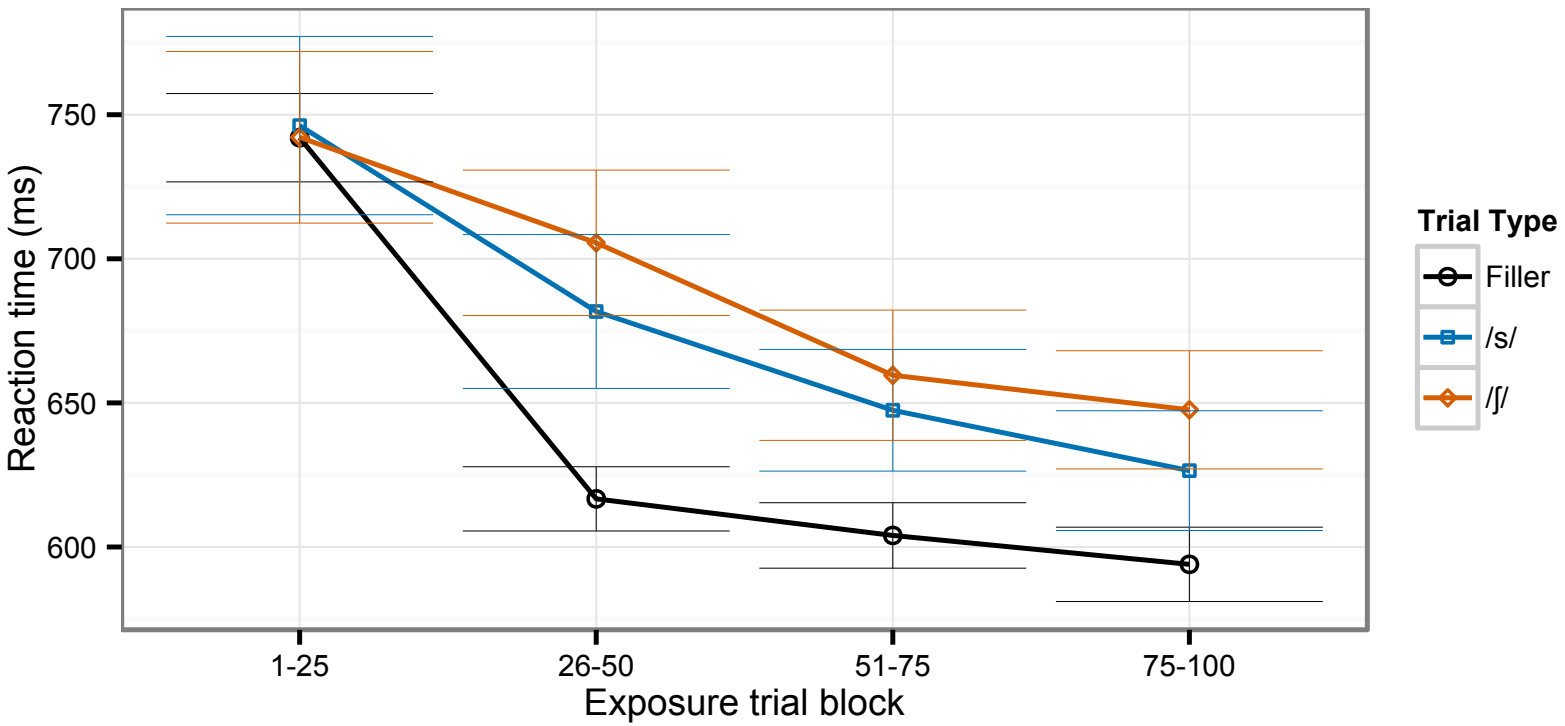
Experiments 1 and 2 - Cross-over and word responses



Experiment 3 - Acoustic analysis



Experiment 3 - Exposure RT



Experiment 1 and 3 - Cross-over distribution