Economy and invariance are unjustified assumptions in formal phonology

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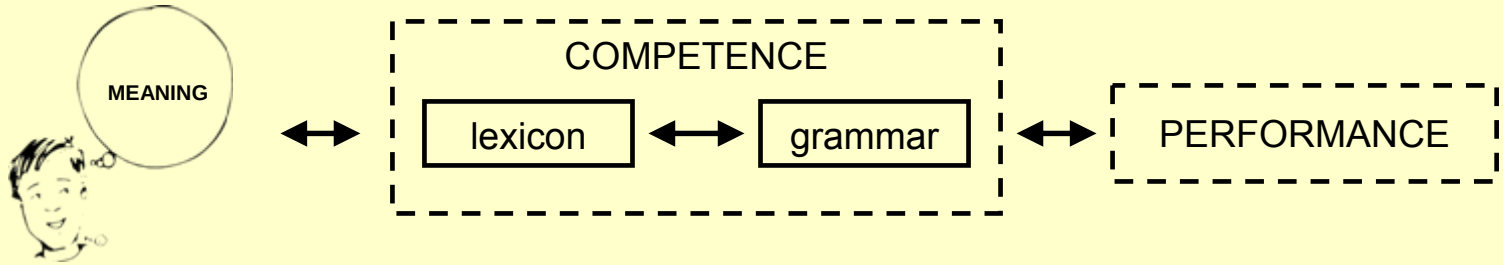
Traditional linguistic model



What is a FORM in competence?

-only performance is directly observed

-competence (then meaning) is inferred

How is a (possible) FORM identified?

-a **minimal pair** demands explicit formal representation in competence

Minimal pair

bʌg		pʌg
+	consonantal	+
—	continuant	—
—	sonorant	—
—	nasal	—
—	coronal	—
+	labial	+
—	strident	—
+	**voice**	**—**

Traditional linguistic model

1. **How many forms?**

   Greek, about 24
   Port-Royal, 25-30
   Jakobson-Fant-Halle, 12
   SPE, about 40
   Optimality Theory, assume *SPE'* s 40 or so
   no consensus, but features must be

   limited in number: *economy*

   Why? descriptive simplicity, computational tractability, typological universality, elegance, Occam, etc.

2. **What is the nature of a form?**

   timeless and perfective: *invariance*

   Why? perfectly recognizable, modular naivety, aut Caesar [Chomsky] aut nihil, perception depends on bi-directionality, Universal Grammar, "represent the phonetic capabilities of man" (*SPE*: 295), transmittable, etc

Traditional linguistic model

Benefits of assuming economy and invariance:

1. tractable due to constrained resources (storage space, processing)

2. powerful: limited units of representation, unlimited output

Potential costs of assuming economy and invariance:

1. power is a function of economy: as more forms are admitted to the model (ie, less economy), theoretical power declines.
   What evidence challenges the proposition of economy?
   ID minimal pairs, increasing # of necessary forms
2. model has no way of dealing with variance. If variation is found, there is no apparent or obvious way out.
   What evidence challenges the proposition of invariance?
   flexible linguistic representations (forms) over time

Empirical research questions

Experiment 1: test economy

(1a) are there (new) minimal contrasts for words differing by lexical usage frequency?

(1b) are there (new) minimal contrasts for words versus non-words?

Experiment 2: test invariance

are linguistic categories (forms) flexible?

can experience easily affect representations (forms)?

Experiment 1a & 1b: economy

DV: VOT boundary (ms)

IV: lexical status

(word, non-word)

LEX-STATUS	[d] non-word	[d] word
[t] word	*talc ~ dalc*	*teal ~ deal*

usage frequency

(high, low)

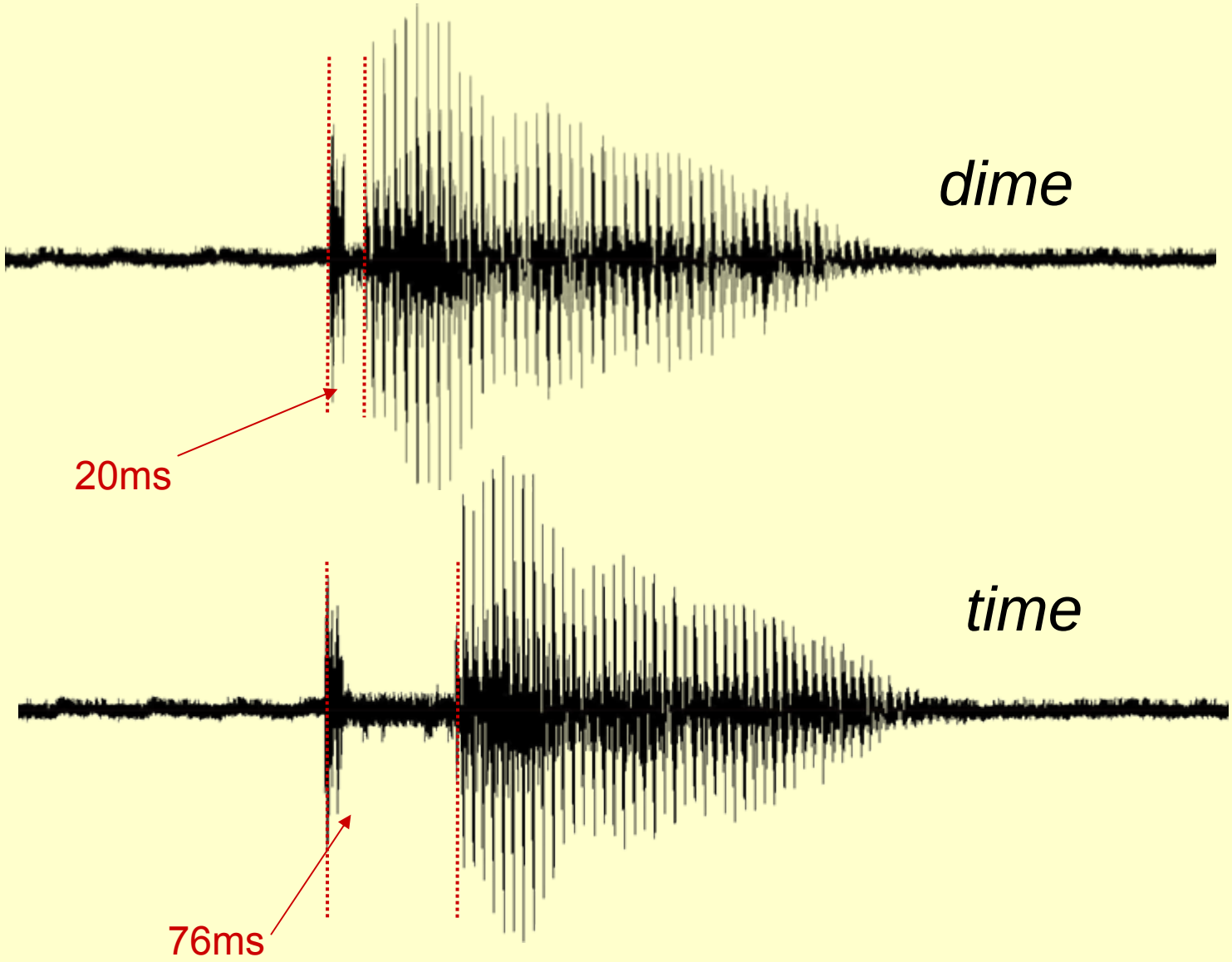
USAGE-FREQ	[d] low-freq	[d] high-freq
[t] low-freq	*tine ~ dine*	*ton ~ done*
[t] high-freq	*time ~ dime*	*town ~ down*

Task: for 30 word pairs; presented with an acoustic token from VOT continuum, then identify "***A*** *for 'teal'* ***B*** *for 'deal'"*

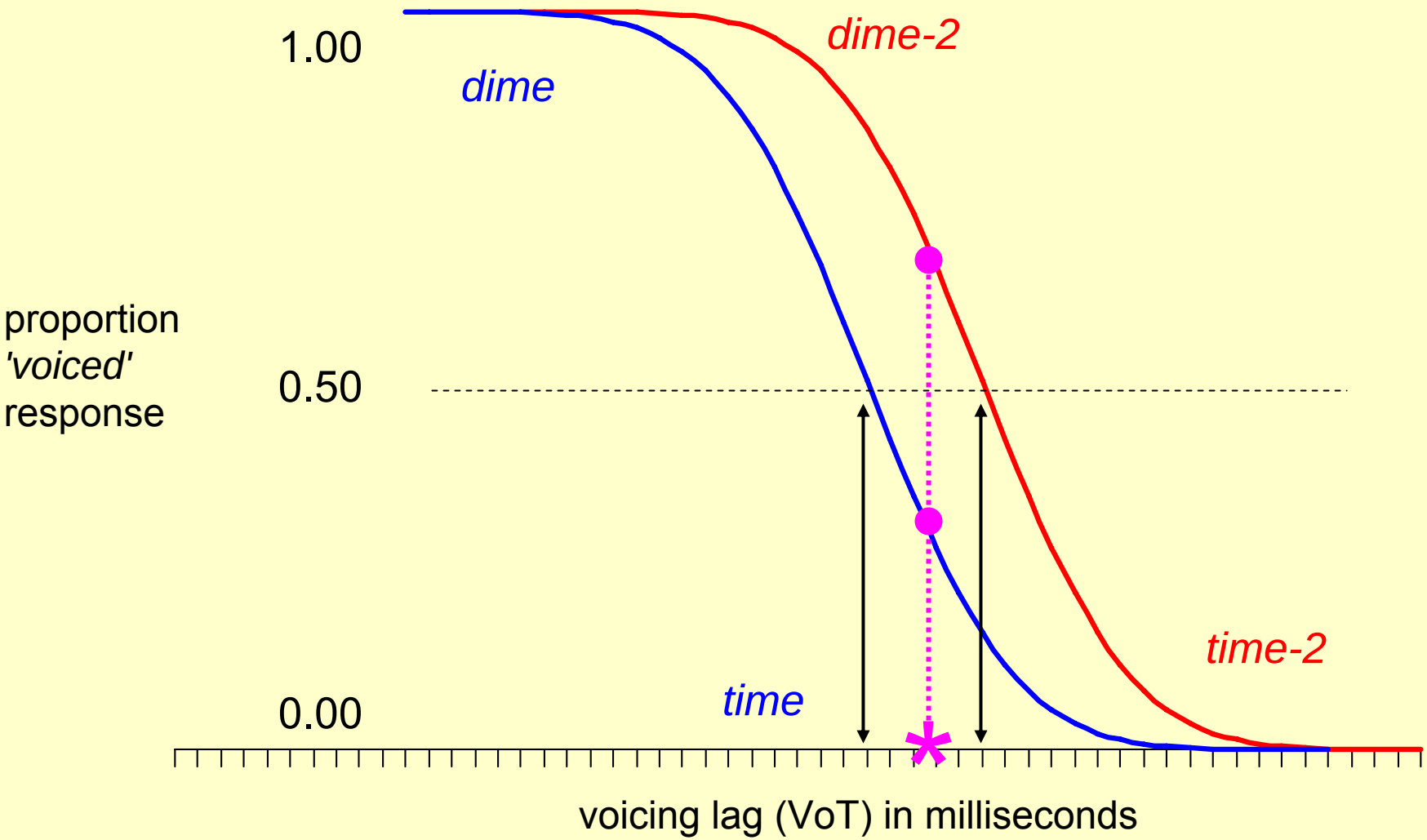
Data: 220k responses, 27k boundaries

Analysis: differences among voicing boundary locations

Voice-onset time (VoT):



Anatomy of a category boundary shift



Experiment 1a & 1b: economy

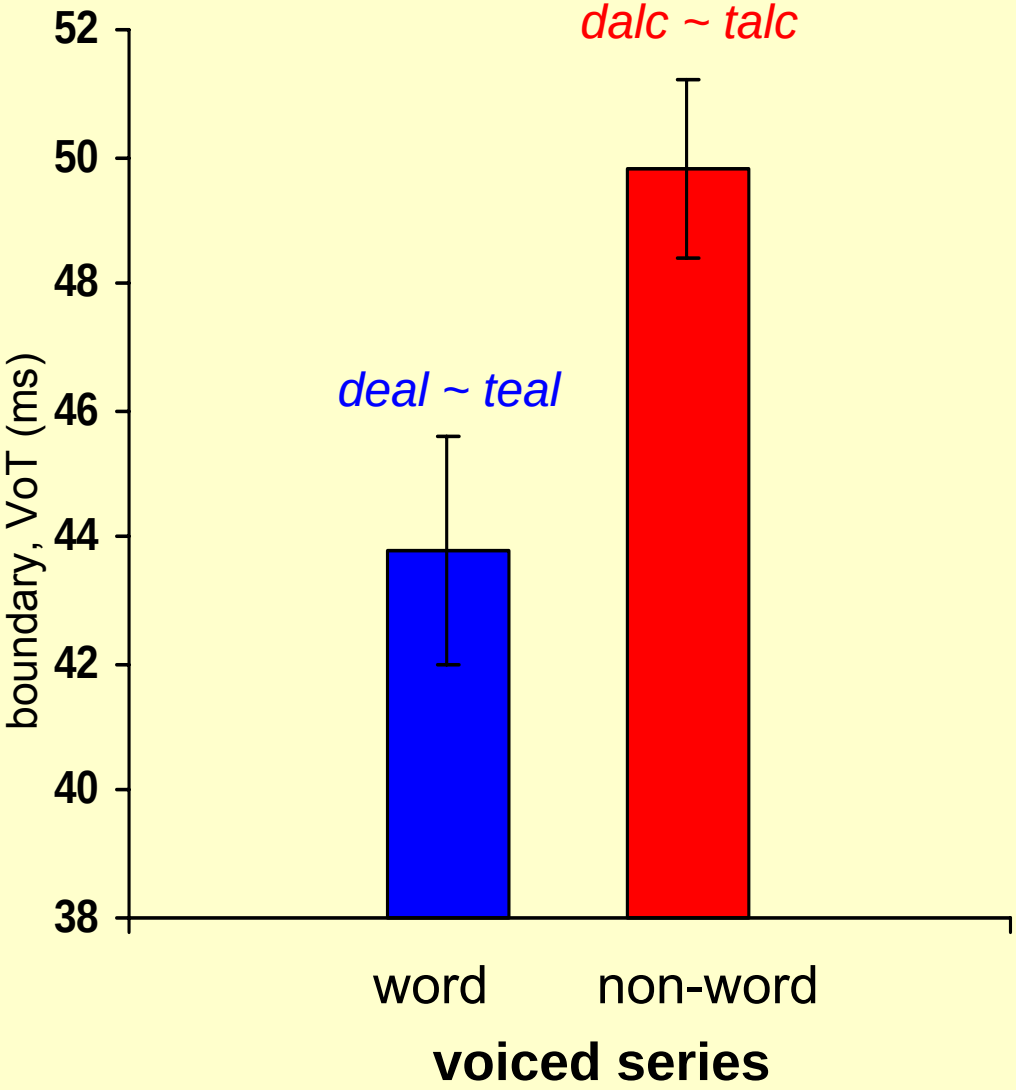
Are voicing boundaries different based on lexical status?

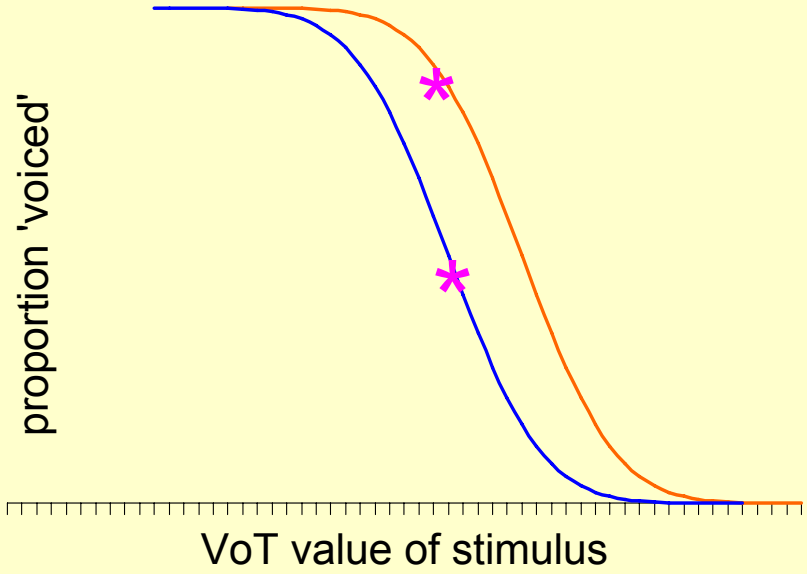
LEX-STATUS	[d] non-word	[d] word
[t] word	*dalc ~ talc*	*deal ~ teal*

Are voicing boundaries different based on lexical usage frequency?

USAGE-FREQ	[d] low-freq	[d] high-freq
[t] low-freq	*dine ~ tine*	*done ~ ton*
[t] high-freq	*dime ~ time*	*down ~ town*

Non-word bias over words



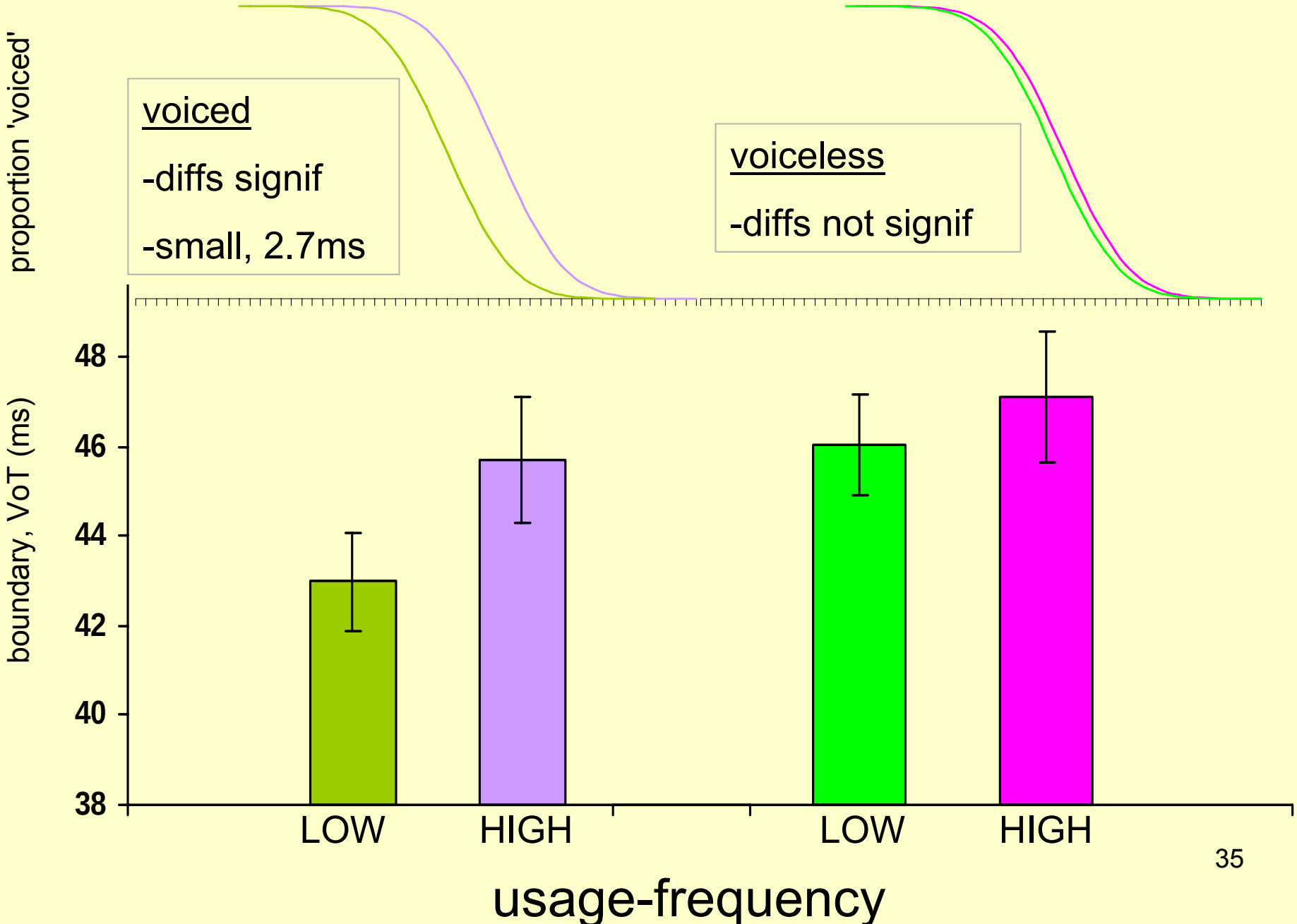


-diffs significant

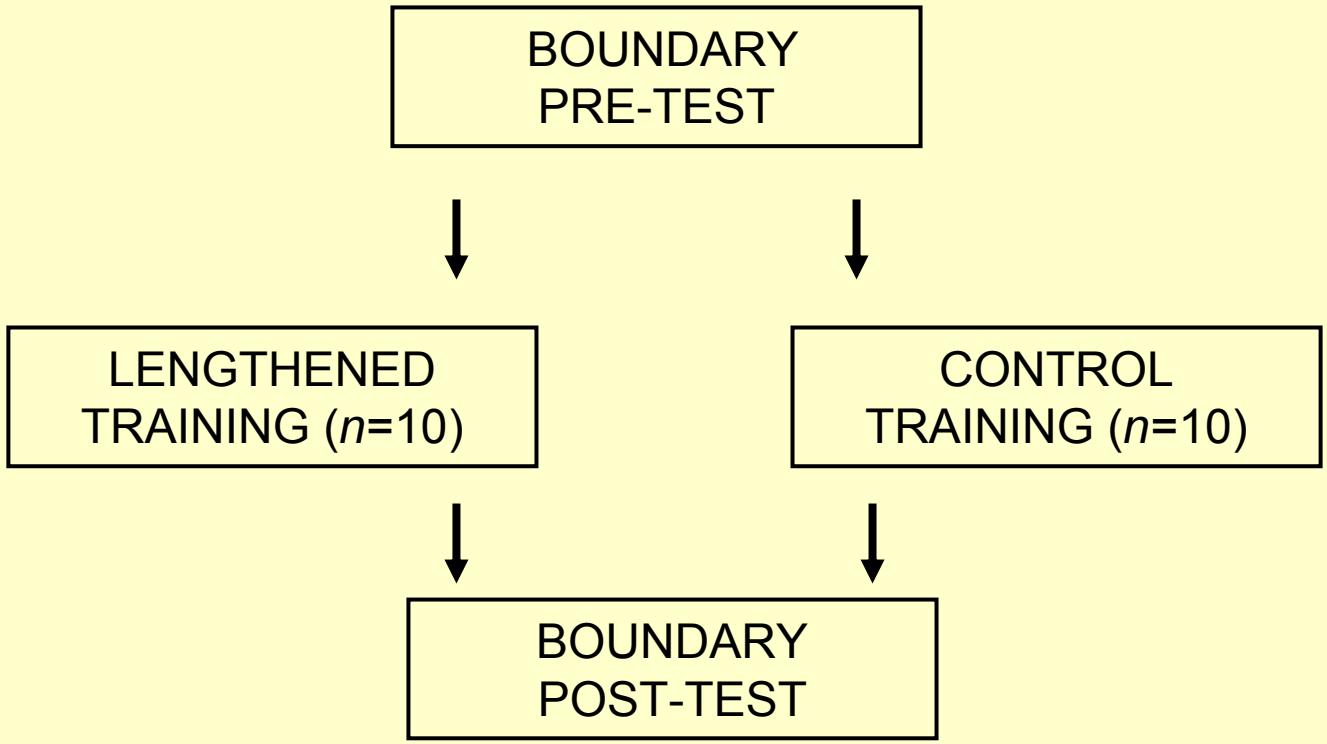
-diffs small, 6.0ms

-bias only tested in voiced series

High usage-frequency bias, voiced only



Formal invariance



Methodology, Experiment 2: formal invariance

DV: VOT boundary (ms)

IV: training exposure (control, lengthened)

control targets = 80% VOT for 12 target words
lengthened targets = 180% VOT for 12 target words

test condition (pretest, posttest)

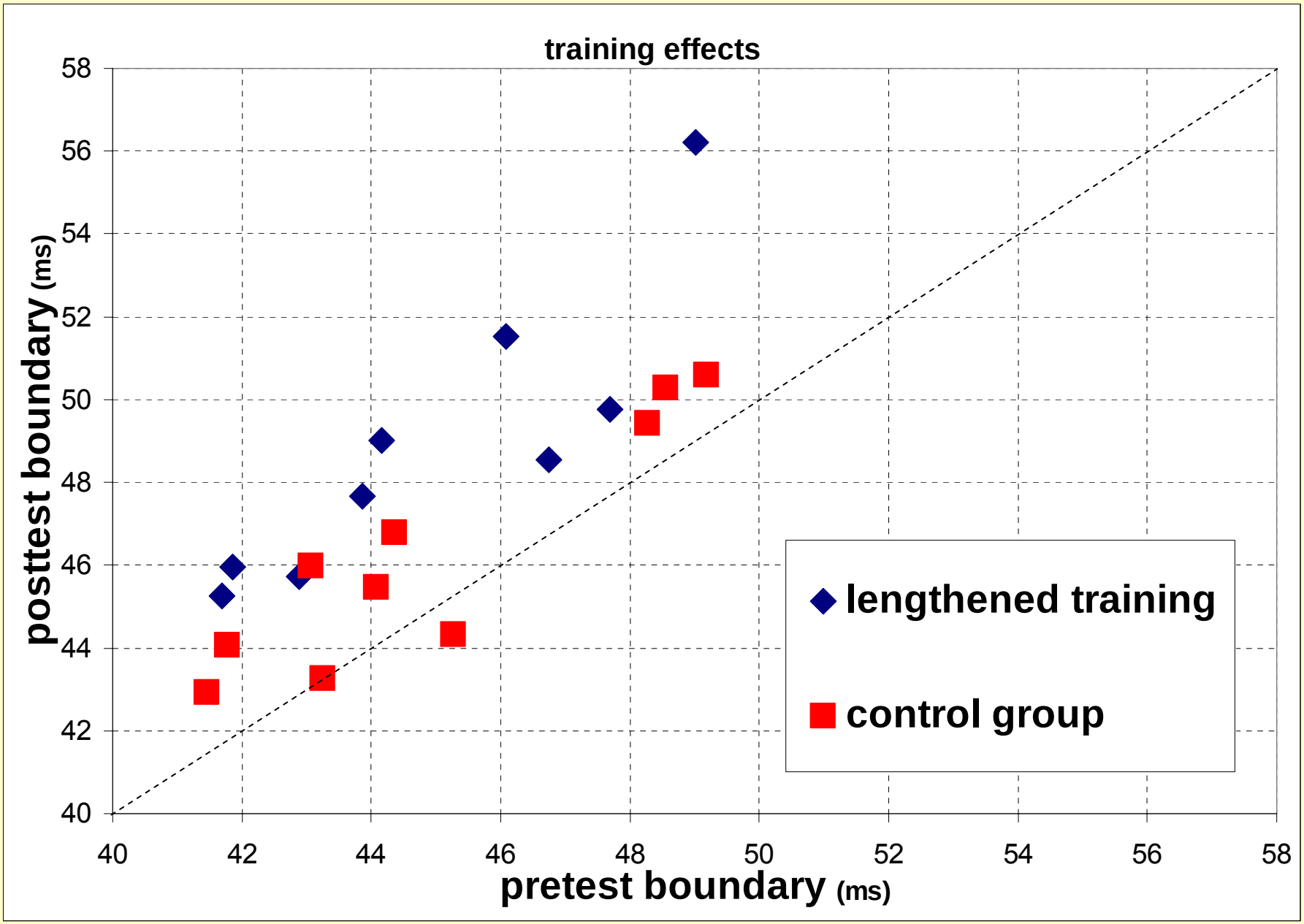
Procedure: pretest, training (5 days), posttest

Task (pretest and posttest): "press **A** for TEAL or **B** for DEAL"

Task (training): listen-and-repeat phrases from 4-minute/600 word story. 12 voiceless targets occur twice each in story.

eg: *over the rusty keel section of the boat*
buy all the talc from the general store

Analysis: differences among voicing boundary locations


training effects
posttest boundary (ms)
pretest boundary (ms)
40
42
44
46
48
50
52
54
56
58
lengthened training
control group

Results recap

Exp-1a. lexical status: word versus non-word?

non-word bias in the voiced series

ie, *dope-taupe* and *dop-top* have different structure

→ the two minimal pair contrasts differ

→ formal model demands unique form to represent lexical contrast

Exp-1b. usage frequency: high versus low frequency?

high-frequency bias, voiced series only

ie, *done-ton* and *den-ten* have different structure

→ the two minimal pair contrasts differ

→ formal model demands unique form to represent frequency contrast

Exp-2. category flexibility: controlled versus lengthened exposure?

lengthened exposure changed category boundary, control did not

ie, experience with longer tokens changed structure of category

→ linguistic voicing category is highly flexible

→ formal model cannot account for this data

Present results compatible with other work

(1) perceptual learning

(Kraljic & Samuel 2005, 2006; Norris, McQueen, & Cutler 2003)

(2) listener sensitivity to variability

(Labov 1963; Hooper 1976, Volaitis & Miller 1992; Sancier & Fowler 1997)

(3) exemplar-, episodic-, rich-memory language models

(Goldinger 1997, 1998; Pierrehumbert 2001; Johnson 1997; Port 2007)

(4) usage-based models

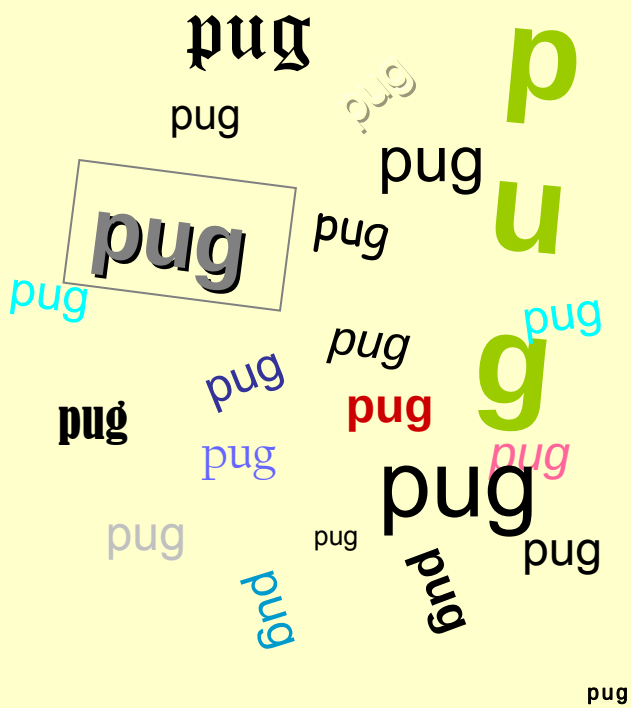
(Hooper 1976; Phillips 1984; Johnson 1997; Bybee 2002)

Formal-theoretic assumptions of economy and invariance are violated.

What sort of theory can account for the facts?

Abstract and detailed representation, Rich-memory approach

	p	ʌ	g
consonant	+	—	+
continuant	—	+	—
sonorant	—	+	—
nasal	—	—	—
coronal	—	—	—
labial	+	—	—
strident	—	—	—
voice	—	+	+



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