Phonetic experience with specific words affects categorical perception of those words

Mark VanDam[1] & Robert F. Port[2]

[1]Boys Town National Research Hospital, Infant Development Lab

[2]Indiana University, Department of Linguistics

vandamm@boystown.org www.VanDamMark.com

157th Acoustical Society of America

3pSC

Portland, OR 20 May 2009

BOYS TOWN National Research Hospital SM

INDIANA UNIVERSITY

Main Point

Fine phonetic detail is perceived and stored in memory. A few dozen exposures to the phonetic detail of overlong VOT affected perception of the voicing contrast. The effect did not pervade the lexicon (i.e., training did not generalize) but was sensitive to lexical status (word v. non-word) and usage frequency (high v. low). Results are incompatible with the traditional linguistic model but are easily accounted for in an exemplar-type, rich-memory language model, and are likely to have practical applications.

Background

Memory for language is affected by experience over a fairly short time frame of hours (Shockley et al 2004) or days (Goldinger 1996; Eisner & McQueen 2006).

Linguistic experience affects language perception/memory: verbal transformation (Warren & Gregory 1958), selective adaptation (Corbit 1973), shadowing (Porter & Lubker 1980), accommodation (Pardo 2006; Sancier & Fowler 1997), usage frequency (Bybee 2000), lexical bias (Ganong 1980), and perceptual learning (Norris, McQueen, & Cutler 2003).

Experiences or exposures add to memory representations (Pierrehumbert 2001), affecting language use, speech production, and speech perception.

Rich memory (or: *exemplar, episodic, high-* or *richly-dimensional*) account for facts mentioned above (see, Port & Leary 2005), but the traditional linguistic model fails.

Research Questions

1. Does modest exposure to words with lengthened VOT affect perception of VOT boundary?
2. If there is an exposure effect,
   a. does it generalize to similar forms or is it lexically restricted?
   b. are high- and low-frequency words affected differently?

Methods

Design and Procedure

__Pretraining__: 2AFC, word-ID test on 12 voicing continua (top pair in each cell in Table 1 below).

__Training__: participants in the Lengthened-VOT training group (n=10) heard the 12 target words with VOT 180% longer than natural; a control group (n=10) heard targets with VOT 80% of natural. Listen-and-repeat ordered phrases from 600-word story four times on each of five training days.

__Posttraining__: same as pretraining, plus 12 similar continua (bottom rows or words in matrices below).

Comparison	to test for...	in Figure
a. pretraining v. posttraining	training effect	1, 2
b. test words v. new words	generalizability	1
c. high- v. low-frequency	frequency bias	3
d. word v. non-word	lexical bias	3

Stimuli

One man and one woman (both 25 yrs old) naturally produced the training story and voicing continua endpoints. Target VOT was then lengthened to 180% of the natural VOT or shortened to 80% of the natural VOT. The **lengthened-VOT training group** were exposed to the overlong targets and the **control group** to the slightly shorter targets, but otherwise received identical stimulus.

Participants

→ 13 women, average 25.3 years old

→ 7 men, average 31.4 years old

→ monolingual American English talkers, normal hearing and vision, no speech or language deficits, all right-handed

Materials

The training story (~600 words) contained each target word twice:

...so they decided to go __down__ from their hill...to a neighboring city...to __dine__ hurriedly at a local pub...and get dye to __tint__ some of the __caulk__ for their project...

	non-word [g]	low freq [g]	high freq [g]
low freq [k]	kiln - giln kith - gith	caulk - gawk coo - goo	cot - got curl - girl
high freq [k]	keep - geep can - gan	call - gall car - gar	could - good came - game

Table 1. TARGET WORDS. Lexical status (word v. non-word) and lexical frequency (high v. low) are shown for word pairs differing by the voicing of the initial consonant. **Word-initial voiced stops are in green** and **voiceless in pink**. In each cell, the top pair is a sample of the pre- and post-training words and the lower pair is a sample of the words used in the generalization condition. Figure 3 uses the same colors: boundaries determined only by **voiced stops** are shown in green and boundaries determined only by **voiceless stops** are shown in pink.

Results

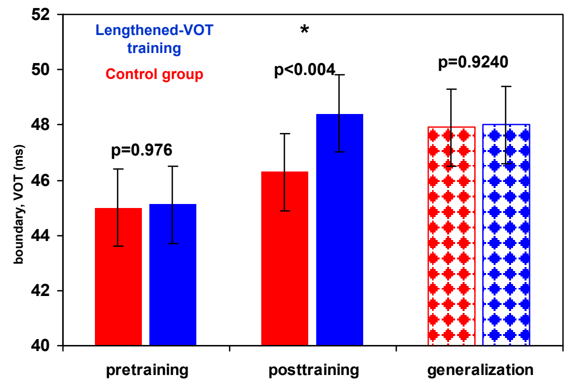

Figure 1. POOLED TRAINING and GENERALIZATION. Subjects trained on lengthened-VOT are shown in blue and subjects in the control group are in red. The solid bars indicate a shared lexical set and the checkers indicate a similar but different lexical set. The longer blue bar in the posttraining condition shows the test group has a posttraining boundary shift in the direction of training (i.e., longer), but the lack of difference in the generalization condition (checkered bars) suggests the effect did not pervade the lexicon.

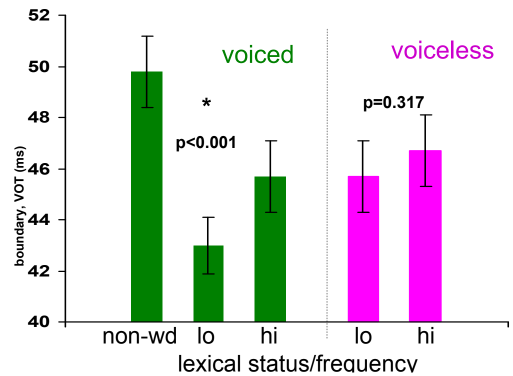

Figure 3. LEXICAL FREQUENCY and LEXICAL STATUS. Each bar shows the voicing boundary by lexical frequency or lexical status within the specified voicing category. The expected bias for high frequency words over low frequency is shown in the voiced category. Longer boundary locations for non-words over words in the voiced category was surprising, and opposite to the Ganong-effect. Lexical effects were not observed in the voiceless category.

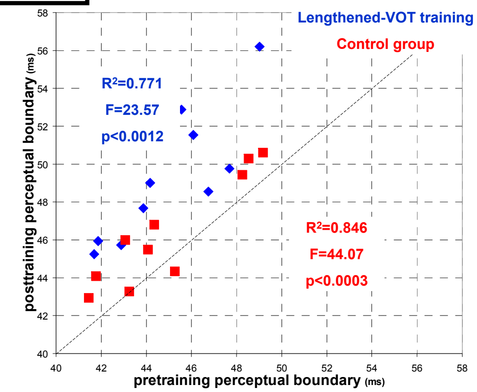

Figure 2. TRAINING BY SUBJECT. Individual subjects trained on lengthened VOT are in blue markers and the control subjects are in red markers. Perception of the voicing boundary is plotted before training on the x-axis and after on the y-axis. The two groups are significantly different and the lengthened-VOT group is significantly longer at posttest (i.e., farther from the dashed diagonal).

Conclusions

1. Fine phonetic detail

a. is easily, quickly trained (~40 exposures)

b. can be lexically specific (i.e., does not generalize)

c. can be sensitive to usage-frequency

d. is used differently in various linguistic conditions:

i. non-word categorization bias (anti-Ganong)

ii. important for voiced series but not voiceless

2. Rich-memory models account for the present results but the traditional language model does not.

3. A better understanding of the plasticity of perceptual categories may have implications for clinical or rehabilitative applications (hearing impairment, stroke, SLI), language acquisition (native or L2), language learning (educational testing standards, artificial intelligence, automatic speech recognition), language change (rate or location of change, dialect research), methodological design (rate and number of exposures required), and improving language models (testing or verifying assumptions, claims, and hypotheses).