4pSC34

Generalization of the imitation effect within a natural class

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Introduction

- **Invariant/Prototype View** of Speech Perception
  - Linguistic representation is abstract and invariant = **prototype** (e.g., Halle,1985)
  - No knowledge of individual token (exemplar)

- **Exemplar View** of Speech Perception
  - Each category is represented in memory by a large collection of remembered **exemplars** (e.g., Hintzman,1986)
  - No knowledge of prototype

Introduction

- A key prediction of **exemplar-based** theories: **specificity effects**

- Specificity effects have been found in the:
  - **Repetition Priming paradigm**
    - **Already experienced tokens are processed faster than new ones:**
    - **Interpretation - Detailed information in the memory facilitates speech processing** (e.g., Mullennix et al., 1989)

Introduction

–Imitation paradigm

- **Subjects' speech is compared before and after they are exposed to target speech**
- **Subjects shift their production in the direction of the target**
- **Interpretation - Surface information in speech affects speech production**

- **Goldinger** (1996, 1997, 1998) *voice & F0 in single-word shadowing, (2000) voice non-shadowing*
- **Shockley et al.** (2004) *voice & VOT in single-word shadowing*

Issues

In terms of understanding the effects of speech input in underlying ***linguistic representation…***

- Variable: Voice, F0 vs. VOT
  - ➔ More likely to carry linguistic information
- Paradigm: Shadowing vs. Non-shadowing
  - ➔ more likely to reveal underlying *linguistic representation*

No one has yet looked at a linguistic variable (e.g. VOT) in a long-term (non-shadowing) task

Issues

- According to exemplar theories, exemplars are activated according to their ***similarity*** *to the new stimulus*

- The notion of **"natural class"** :

  ➔ In phonology, similarity is often defined by natural class
  ➔ How psychologically real is "natural class"?

- Is linguistic information (e.g., features) generalized beyond tokens?

  ➔ Could episodic memory be **across-the-board**?
  How far do we generalize? Segments? Features?

Issues

- Exemplar theories predict a larger specificity effect for low-frequency words than high-frequency words (low frequency = less exemplar -> weight of one exemplar is relatively bigger)
  - Goldinger (2000): Significant effect of lexical frequency in non-shadowing task *(voice)*
  - Shockley et al. (2004): All stimuli are low-frequency words *(VOT)*
  - *Is there an effect of lexical frequency in non-shadowing VOT imitation?*

Goals

- To investigate

1) VOT imitation effect in *non-shadowing* paradigm

2) generalizability of the effect to *new stimuli*

3) effect of *lexical frequency* in VOT imitation effect

Key stimuli: Exaggerated VOT(40ms)

– Are they imitated?

Method

- **Participants:**
  - 8 native speakers of American English (4M & 4F) with normal hearing and reading
  - Received course credit for participating

Method

- **Stimuli**
- **Listening list** (for study-phase)
  - 80 target words with initial /p/
  - 40 filler words with initial sonorants
- **Production list** (for baseline and test phase)
  - 120 target words

    1) the modeled words (the targets in listening list)

    2) the modeled segments /p/ in new words

    3) the modeled feature [+spread glottis] in a new segment /k/
  - 30 filler words with initial sonorants

Method

- **Stimuli (continued)**
  - **Lexical frequency**
    - Kŭcera & Francis (1967) Hi>50, Low<5
    - CELEX2 (Baayen, Piepenbrock and Gulikers, 1996): Hi>1000, Low<300
  - **Phonological neighborhood density & syllable length :**
    - controlled between frequency groups
  - **Familiarity:**
    - 6.0-7.0 on the 7-point Hoosier Mental Lexicon scale (Nusbaum et al., 1984)
  - **All the target words had initial stress, no onset clusters**

Method

- A phonetically trained male American English speaker recorded the 120 words in the listening list
- The speaker produced:
  1) All the words normally, and
  2) The target words *with extra aspiration*

- The VOT for the normally produced initial /p/ was extended by 40ms
  - Spliced with the initial part of hyper-aspirated tokens (PCquirer: Scicon R&D, CA) to maximally preserve natural formant transitions
  - The extended tokens had average VOT of 113.26 ms (SD=10.82ms)
  - 1.56 times longer than original (Shockley et al: 2.03 times longer)

➔ /p/ initial stimuli all have longer VOT

Procedure

- The experiment used a slightly modified version of the imitation paradigm from Goldinger & Shockley et. al.
- A warm-up silent reading phase was added at the beginning to avoid possible hyper-articulation
- The stimuli were presented using Psyscope 1.2.5 (Cohen, et al., 1993)

Procedure

1. **Warm-up** Phase: Subjects read the production list silently
2. **Baseline** (Pre-study) Phase: Subjects read the production list aloud
3. **Study Phase**: Subjects listened to the listening list (no other task)
4. **Test** (Post-study) Phase: Same as the Baseline Phase above.

The subjects' tokens were digitally recorded into a computer and VOTs were measured using both waveforms and spectrograms

Results & Discussion

Independent Variables:

- **Pre vs. Post-study** (= Imitation Effect)
- **Lexical Frequency** (high vs. Low)
- **Heard vs. Unheard Items**
- **Linguistic Unit of Generalization** (segment:/p/ vs. feature:/k/)

Results & Discussion

- Significant difference between pre- and post-study phase production across all types of stimuli = **imitation effect** : ($F(1,7)= 6.488$, $p<.05$*)

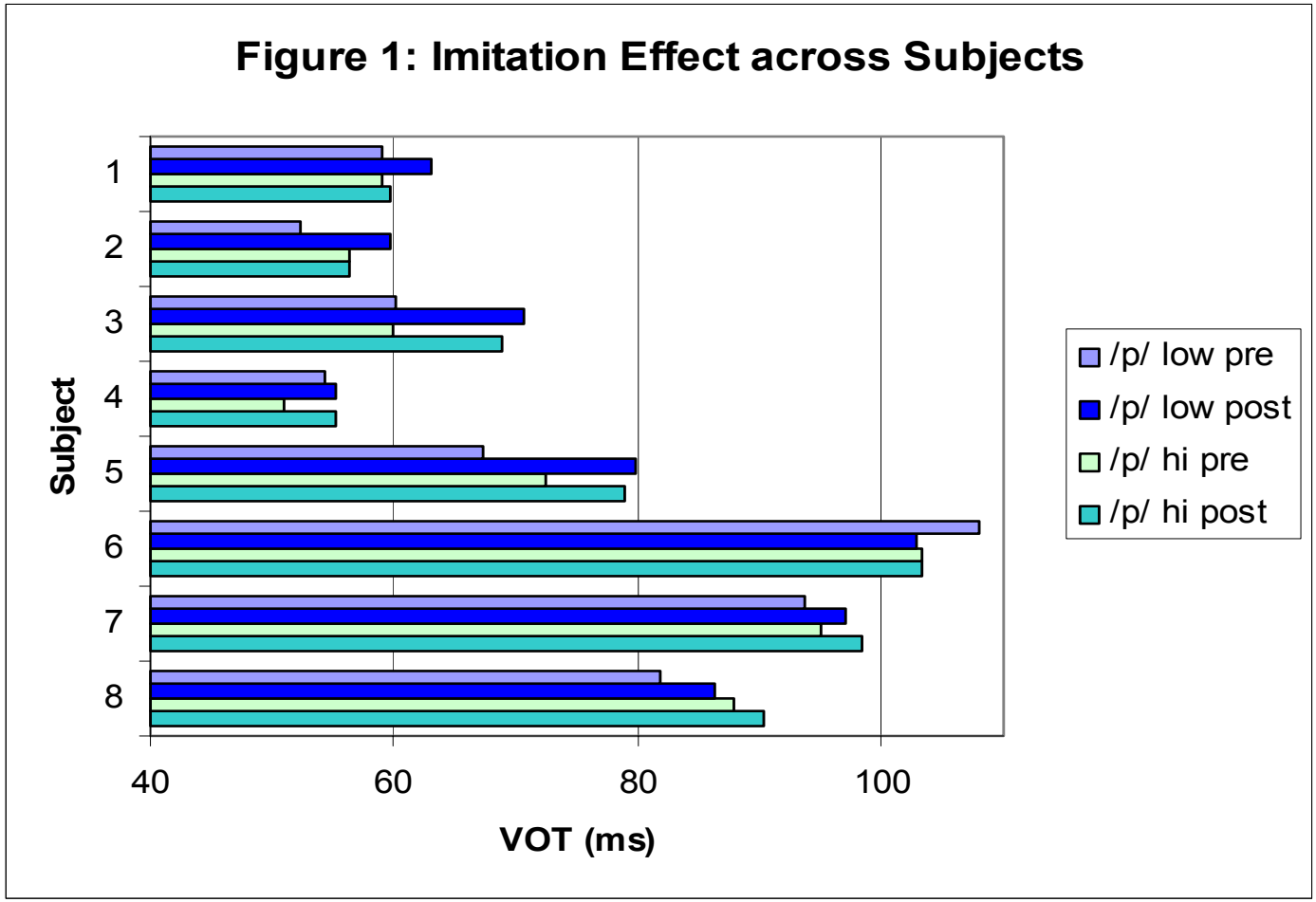
- In this study, no statistically significant interaction between the imitation effect and other variables was found

Results & Discussion

Repeated-measures ANOVA with two within-subjects factors

1. pre vs. post x lexical frequency
   - **pre- and post ($F(1,7)= 6.488$, $p<.05$*)**
   - high and low frequency ($F<1$, $p>.1$)
   - Interaction ($F<1$, $p>.1$)
2. pre vs. post x heard vs. unheard
   - **pre- and post ($F(1,7)=6.857$, $p<.05$*)**
   - heard vs. unheard ($F<1$, $p>.1$)
   - interaction ($F<1$, $p>.1$)
3. pre vs. post x segments
   - **pre- and post ($F(1,7)=6.023$, $p<.05$*)**
   - /p/ and /k/ ($F(1,7)=125.797$, $p<.001$*)
   - **interaction ($F<1$, $p>.1$)**

Results & Discussion



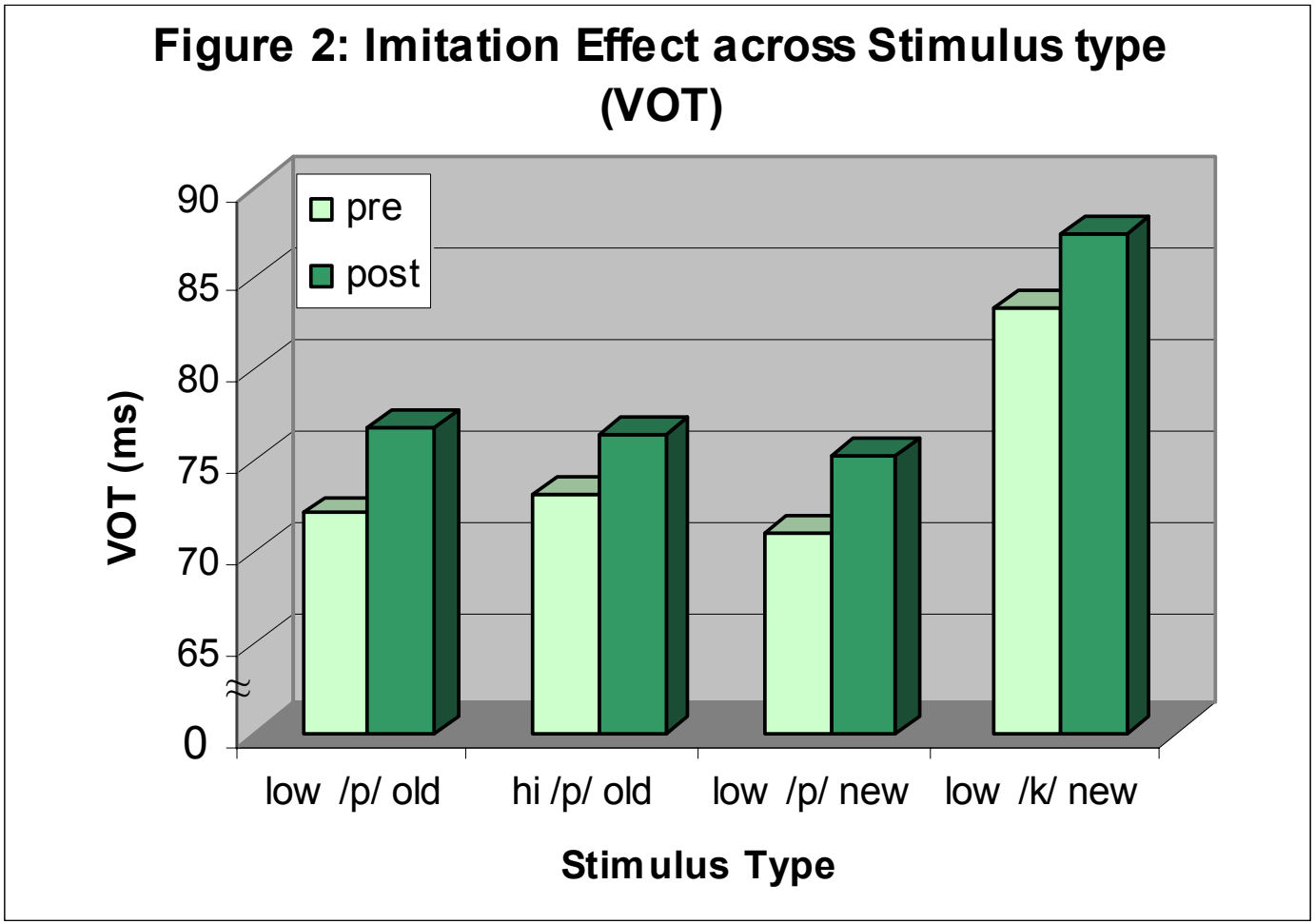
Blue and green bars represent high- and low-frequency stimuli, respectively.
Subject # 1-4 are male, 5-8 are female. All of them heard the same stimuli.

Results & Discussion

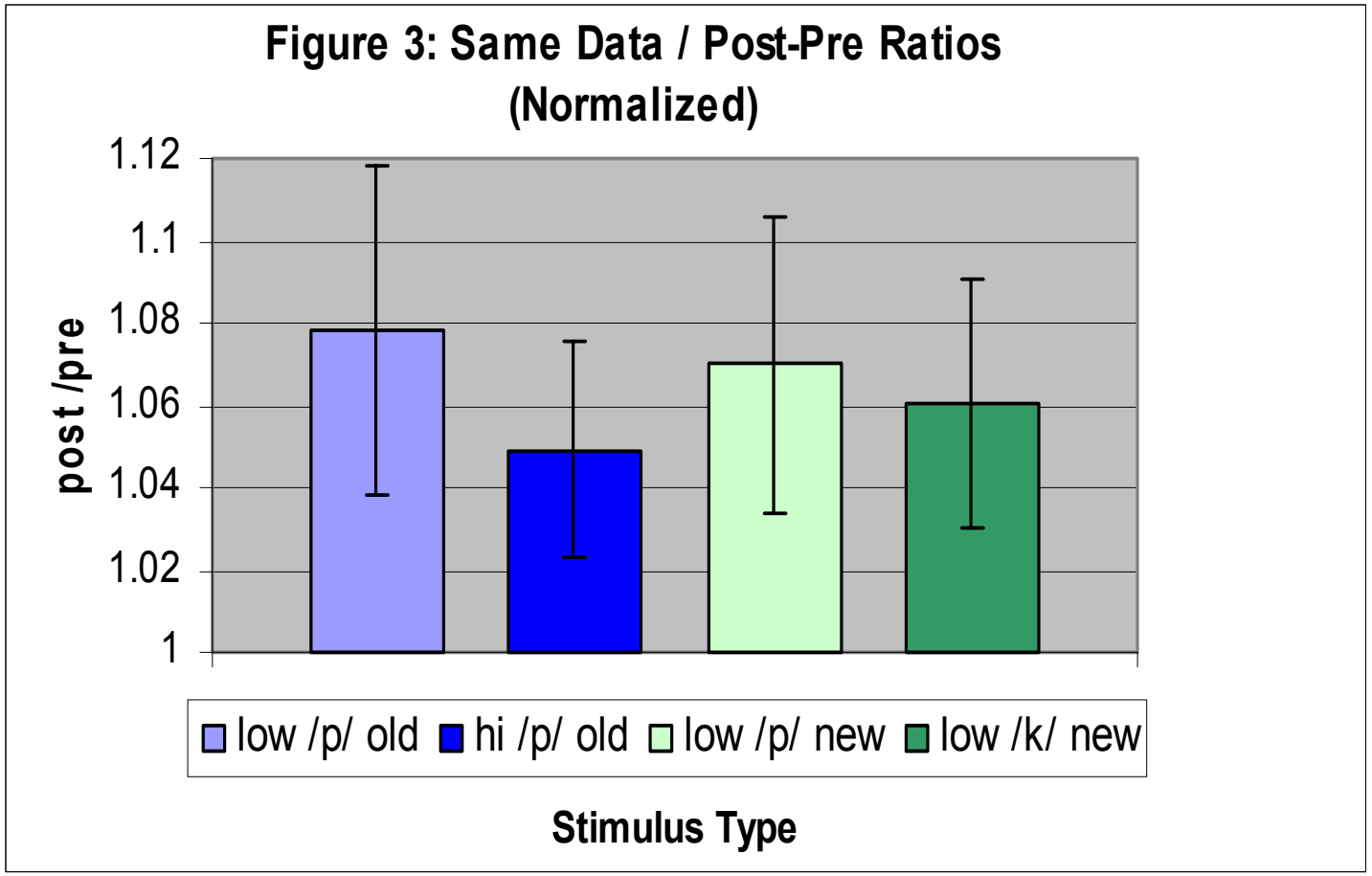
- 7 (4 male, 3 female) out of 8 subjects produced longer VOT in the post-study (=test) phase

- 5 (3 male, 2 female) out of 8 subjects produced stronger pre- vs. post effect for low-frequency words

Results & Discussion



Results & Discussion



Post-study (test) VOT was divided by pre-study (baseline) VOT

Results & Discussion

- Exemplar theories predict the imitation effect to be **stronger for low-frequent words**
  - Our results did not show support the prediction

- Generalization Effects:
  - The effect was generalized to:

    1) New words which share the initial phoneme /p/

    2) New segment /k/ which shares a feature [+spread glottis] (and: [-continuant, -sonorant, -voice]) = natural class
  - Suggests that exemplars could be as small as a feature

Results & Discussion

- **The next step: measure other variables (e.g., the following vowel, the entire word)**
  - If the imitation effect is truly due to episodic memory, only the manipulated variable (in this case, VOT) should be affected
  - If we observe changes in other variables, the imitation effect is more likely to be due to a more global aspect of speech production

    (e.g. register “speak more carefully”)

Conclusion

1. **The imitation effect for VOT was found in a single-word non-shadowing paradigm**

2. **The effect was significant across:**
   - Target words (heard in study phase) with high and low frequency
   - New words with initial /p/ and /k/

   ➔ ***Generalized to new words and new phonemes***

3. **Effect of Lexical frequency on VOT imitation effect:**
   - Not found in our data

References

Goldinger, S. D. (1998). Echoes of Echoes? An Episodic Theory of Lexical Access. *Psychological Review,* 105 (2), 251-279.

Goldinger, S. D. (2000). The Role of Perceptual Episodes in Lexical Processing, In *SWAP-2000*, 155-158.

Halle, M. (1985). Speculation about the representation of words in memory. In V. Fromkin (Ed.), *Phonetic Linguistics* (pp.101-114.) New York: Academic Press.

Hintzman, D. L. (1986). "Schema abstraction" in a multiple-trace memory model. *Psychological Review*, **93**, 411-428.

Mullennix, J. W., Pisoni, D. B., & Martin, C. S. (1989). Some effect of talker variability on spoken word recognition. *Journal of the Acoustic Society of America*, 85, 365-378.

Shockley, K., Sabadini, L., & Fowler, C. A. (2004). Imitation in shadowing words. *Perception & Psychophysics*, 66 (3), 422-429.