Sleep facilitates talker generalization of accent adaptation

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BACKGROUND

➢ **Perceptual adaptation to nonstandard speech**

• *Talker-specific learning*: Listeners rapidly overcome initial difficulty in processing non-standard speech signal via top-down guided adaptation [1].

• *Generalization across talkers*: The degree of acoustic-phonetic similarity between talkers modulates the degree of cross-talker generalization in tests immediately after exposure [2].

• *Long-term effects of adaptation*: Limited studies have reported maintenance of talker-specific adaptation (up to one week) [3]. No study has investigated whether listeners' ability to generalize across talkers changes over time.

➢ **The role of *sleep*-mediated consolidation in speech and language processing**

• Sleep promotes generalization from trained speech stimuli to novel tokens or contexts in language tasks such as word learning, non-native phonetic category learning, and adaptation to synthetic speech [4-6].

• Sleep may facilitate abstraction, or protect listeners from interference.

Our Question:

How do listeners, once adapted to a specific foreign-accented talker, retain this learning experience in memory and more importantly, how do they generalize perceptual performance to other talkers?

➢**Does sleep help listeners to retain talker-specific adaptation?**

➢**Does sleep facilitate generalization across talkers?**

METHODS

SPEAKERS

Trained Talker

- 1 male native-Mandarin speaker with medium intelligibility
- Listeners successfully adapted to this talker in a previous study [7].

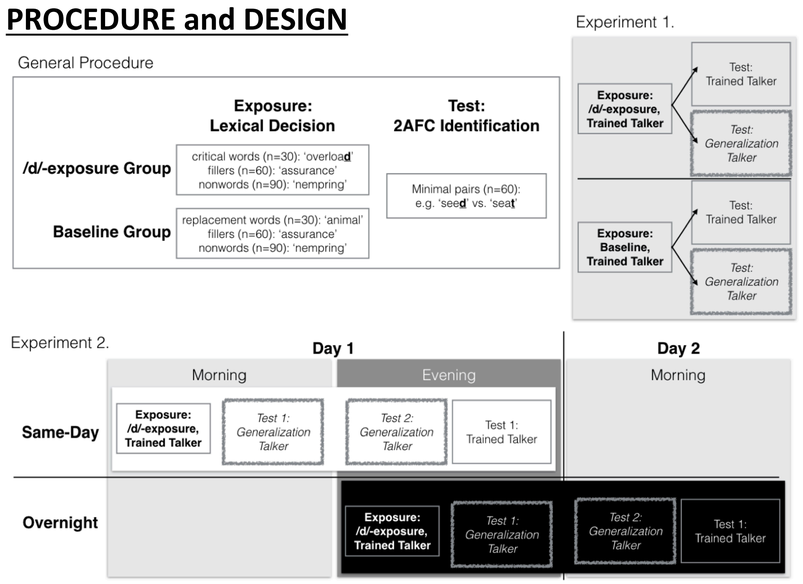
Test Talker

- 1 male native-Mandarin speaker with low intelligibility
- Listeners did not easily adapt to this talker's accent in our previous experiment.

Talker Similarity

- Different productions of word-final /d/ tokens: speech from the test talker was produced with shorter vowels and longer bursts than the trained talker, sounding more /t/-like to native-English listeners.

PROCEDURE and DESIGN



Exp1: Adaptation and Generalization in Immediate Test (N = 48)

➢ **Trained Talker:**

Trained Category: more /d/ responses for /d/-final words among the /d/-exposure group than the Baseline group (β = .30, SE = .15, p < .05).

Untrained Category: no group difference for /t/-final words (β = .04, SE = .16, p = .78).

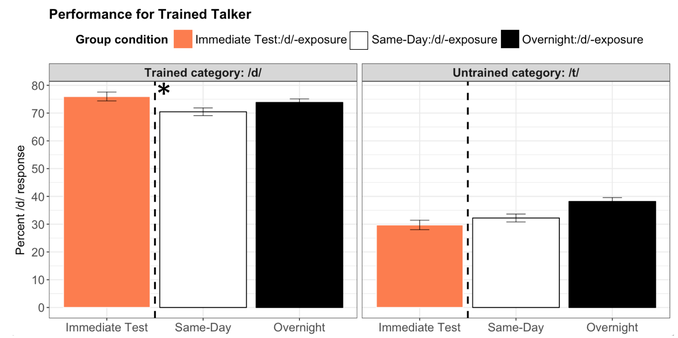
➢ **Generalization Talker:**

Trained Category: no group difference for /d/-final words (β = .19, SE = .19, p = .32).

Untrained Category: no group difference for /t/-final words (β = .0003, SE = .18, p = .99).

Replicated talker-specific adaptation, but no evidence of talker generalization.

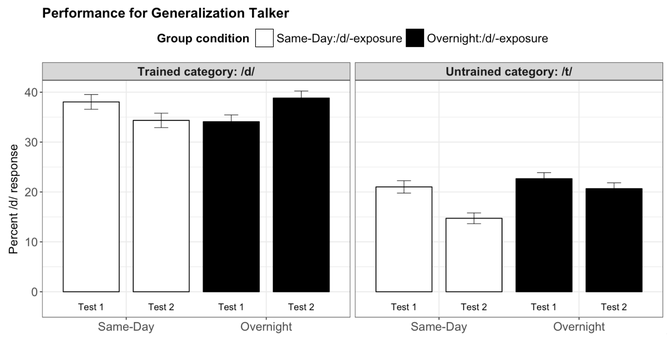
Exp2: Maintenance of Talker-Specific Adaptation and Generalization over 12 Hours: An Examination on the Role of Sleep (N = 38)



➢ **Trained Talker:**

Trained Category: no difference between *Same-Day* and *Overnight* groups (β = -.11, SE = .11, p = .32); *Immediate Test* group had more /d/ responses than *Same-Day* group (β = .28, SE = .13, p < .05), but did not differ from *Overnight* group (β = .18, SE = .13, p = .15).

Untrained Category: no difference between *Same-Day* and *Overnight* groups (β = -.20, SE = .17, p = .24). Neither group differed significantly from Immediate Test group (*p*s > .10).



➢ **Generalization Talker:**

Trained Category: Test Session X Group interaction (β = .12, SE = .05, p = .01).

Untrained Category: Main effect of Test Session (β = .17, SE = .07, p < .05) but no interaction (β = .09, SE = .07, p = .21).

Overnight group showed a weak advantage over Same-Day group with the trained talker, but had significantly better performance with the generalization talker for the trained category.

DISCUSSION

The Maintenance of Talker-Specific Adaptation

➢ **Sleep seems to modulate the retention of talker-specific adaptation:** compared to the /d/-exposure group in Exp1, both groups of listeners in Exp2 exhibited a memory decay with the trained talker over a 12-hour interval. Specifically, both had numerically lower accuracy for the trained category than the Immediate Test group, with the *Same-Day* group being affected to a greater extent than to the *Overnight* group.

➢ **Sleep thus might protect listeners from interfering speech input (e.g., native-accented speech).**

Generalization of Adaptation across Talkers

➢ **Sleep facilitates generalization of accent adaptation to a novel accented talker**: generalization was not observed in the immediate test (Exp.1); after a 12-hour interval, the *Overnight* group gained a perceptual advantage (increased categorization accuracy for the trained category) with the generalization talker over the *Same-Day* group.

➔ **Taken together, sleep appears to facilitate perceptual learning of speech in two ways:**

- **improving access to previously encountered acoustic-phonetic features.**
- **storing salient acoustic-phonetic features abstracted away from the training experience, thereby facilitating perceptual encounters with unfamiliar talkers.**

WORKS CITED:

[1] Norris, D., McQueen, J. M., & Cutler, A. (2003). Perceptual learning in speech. Cognitive Psychology, 47, 204–238.

[2] Xie, X. & Myers, E.B. (under revision). Learning a talker or learning an accent: Acoustic similarity constrains generalization of foreign accent adaptation to new talkers.

[3] Witteman, M. J., Bardhan, N. P., Weber, A., & McQueen, J. M. (2014). Automaticity and Stability of Adaptation to a Foreign-Accented Speaker. Language and Speech, 58, 168-189.

[4] Dumay, N., & Gaskell, M.G. (2007). Sleep-associated changes in the mental representation of spoken words. Psychological Science, 18, 35-39.

[5] Earle, F. S., & Myers, E. B. (2015). Overnight consolidation promotes generalization across talkers in the identification of nonnative speech sounds. Journal of the Acoustical Society of America, 137, EL91-EL97.

[6] Fenn, K. M., Nusbaum, H. C., & Margoliash, D. (2003). Consolidation during sleep of perceptual learning of spoken language. Nature, 425, 614-616.

[7] Xie, X., Theodore, R. & Myers, E. B. (2016). More than a boundary shift: perceptual adaptation to foreign-accented speech reshapes internal structure of phonetic categories. Journal of Experimental Psychology: Human Perception and Performance.

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