Investigating the Neural Basis of Video-game-based Category Learning

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Introduction

A videogame-based training paradigm (Wade & Holt, 2005) has been shown to promote effective learning of both non-native nonspeech (Wade & Holt, 2005) and non-native speech categories (Lim & Holt, 2011).

- This learning recruits speech-selective networks in the left posterior superior temporal sulcus (pSTS) for processing nonspeech sounds after the game training (Leech et al., 2009).
- Nonspeech (Wade & Holt, 2005) and non-native speech categories (Lim & Holt, 2011).

Questions & Specific Aims

- Might the left pSTS region be speech-selective because it supports expertise with auditory categories?
- Does this learning require structured stimulus input?
- Is this region active in online learning?
- Do other speech-selective regions exhibit learning-related change?

Methods

Stimuli
Complex nonspeech category pairs defined in three ways:
- Unidimensional: Perceptually salient cues are present such that categories are separable without training.
- Higher-order with structure: No reliable first-order acoustic information for categorization, but categories are separable in higher-order perceptual space.
- Higher-order without structure: No consistent higher-order structure exists to facilitate categorization; exemplars must be memorized

Experimental Design
fMRI Scan:
- 1.5 sec TR; rapid event related design; AFNI for data analyses
- 1. Localizer: Alien vs. Patch; Speech vs. Nonspeech; Motor movements
- 2. Videogame Training (3 x 12 min)
- 3. Habituation Task (oddball paradigm)

Behavioral Categorization Post-test
- 15 minutes of video game playing to enforce the alien-sound mapping
- Explicit categorization task to indicate alien associated with the sound
- No feedback

Behavioral Results
- All above chance (25%)
- Structured > Unstructured
- Unidimensional (p=0.023)
- Higher-order (p<0.001)
- Categorization of unidimensional sounds, which does not require training, is lower when they are paired with higher-order sounds without acoustic structure than paired with a structure.

Neuroimaging Results & Discussion

Might the left pSTS region be speech-selective because it supports expertise with auditory categories? Is this region active in online learning?

Localizer: Speech > Nonspeech at the left MT/BA 22 (-58, -31, 5)

Video Game Training: Stimulus Processing Phase

- Structural: positive correlation (r=0.564, p<0.05)
- Unstructured: n.s. correlation (r=0.535, p=n.s.)

Do other speech-selective regions exhibit learning-related change?

Localizer: Speech > Nonspeech at the left STG/BA 21 (-58, -7, -1)

References

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