A PERCEPTUAL LEARNING PARADIGM TO SUPPORT PRODUCTION OF A NON-NATIVE VOWEL CONTRAST

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INTRODUCTION

- Learning to perceive and produce sound contrasts in a second language (L2) is especially challenging for adults. Relationship between first language (L1) and L2 matters. [1,2,3]
- Mechanism for how adults learn non-native contrasts may inform clinical strategies for training perception. **Perception gains may also transfer to production** [4].
- Insight from first language acquisition: infants are sensitive to distributions in L1. [5]
  - Bimodal distribution: two categories learned.
  - Unimodal distribution: one category learned.
- Some evidence for **distributional learning effect** (bimodal > unimodal) in adults, but most studies suggest the need for additional supports to train adult perception using distributions.

CURRENT STUDY

- Test whether supports will enhance learning in the unimodal condition.
- Extension to vowel contrast: previous studies included consonantal contrast.

1. **Lexical support:** *Assign image* to category; emphasize presence of 2 categories [6,7].
2. **Active participation:** *Identify* stimulus; immediate knowledge of results (KR) feedback [8].
3. **Overnight consolidation**: Allow *two days* to learn new speech categories [6,9,10].

Do these supports eliminate a distributional learning effect, such that a unimodal distribution leads to as much learning in perception and production as a bimodal distribution?

METHODS

Perceptual Training Stimuli

- Native French speaker produced /œ/, /o/, & filler vowels in /dVt/ within carrier phrase, as in [11].
- Synthesized 8-step continuum.

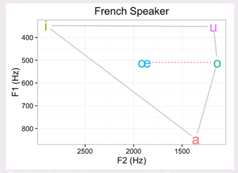

Fig 1. Acoustic relationship between /a/ and /o/ in French speaker.

Step	Ideal F2 (bark)	Actual F2 (bark)
original /œ/	-	**10.95**
1	10.95	10.93
2	10.63	10.63
3	10.33	10.33
4	10.02	10.03
5	9.72	9.73
6	9.41	9.44
7	9.10	9.08
8	8.79	8.79
original /o/	-	**8.79**

Tab 1. Bark distances of natural endpoints and synthesized stimuli.

Perceptual Training Task

- Identify stimulus as (1-4) or (5-8).
- Immediate KR feedback.

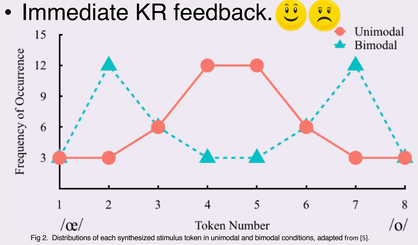

Fig 2. Distributions of each synthesized stimulus token in unimodal and bimodal conditions, adapted from [5].

Outcome Measures:

- **Measures of perceptual learning:**
  - Proportion correct responses in **discrimination task** (ABX): within & across-category contrasts.
  - Proportion of /œ/ responses in **identification task**: like training but no feedback.
- **Measure of production learning:**
  - Euclidean distance (/œ/~/o/) in **repetition task**: repeat natural and synthetic /dVt/ syllables containing /o/ and /œ/ 4x each.

Participants: 34 adult native English speakers; no experience with language with front-back contrast for rounded vowels; assigned to unimodal (n = 17) or bimodal (n = 17) condition.

SCHEDULE

PERCEPTION RESULTS

Discrimination:
Significant learning in both groups.
- Across-category contrasts (steps 3-6)
- Interaction between condition and time not significant.

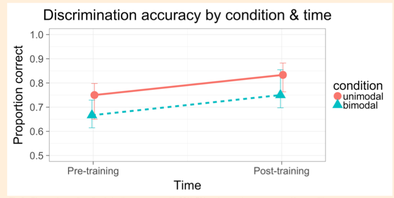

Fig 3. Change in median discrimination accuracy with 90% CI band around mean, grouped by condition.

Identification:
Similar performance at middle of continuum.
- Different performance between groups near endpoints (steps 1,7,8) at pre-training test only.

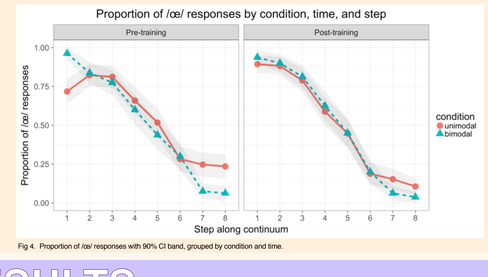

Fig 4. Proportion of /œ/ responses with 90% CI band, grouped by condition and time.

PRODUCTION RESULTS

Repetition:
Euclidean distance (/œ/~/o/) increased for both groups.
- *Natural*: condition and time interaction; unimodal learned more than bimodal.
- *Synthetic*: no condition differences; effect of time.

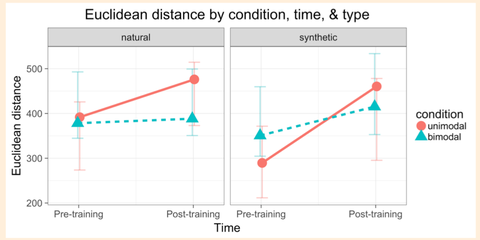

Fig 5. Change in median Euclidean distance with 90% CI band around mean, grouped by condition and stimulus type.

PERCEPTION-PRODUCTION RESULTS

Individual patterns:
- Upon visual inspection, many of those who improved in perception also improved in production.
  - Supports perception-production link.
- Many individual differences, and no clear group differences.

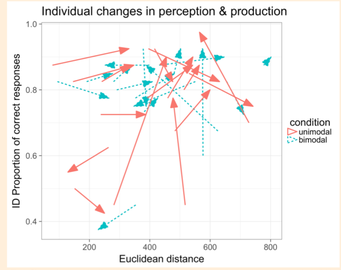

Fig 6. Change in mean identification accuracy and mean Euclidean distance (natural tokens) for individual subjects in each condition from pre (beginning of line segment) to post (arrowhead) time points.

CONCLUSIONS

MAIN FINDINGS

- **Listeners in both conditions improved perception.**
  - Small bimodal advantage observed after first training was no longer present after final training.
- **Listeners in both conditions improved production.**
  - Possible that unimodal group showed greater increase in production, though only observed in natural tokens. (Artifact of stimuli?)
- **Supports perception-production link:**
  - Individual patterns suggest that perceptual learning transfers to production.
- Instead of a bimodal advantage for learning to improve perception and production, as in previous studies, the current study demonstrates that:
  - **A unimodal condition can lead to *as much perceptual learning* as a bimodal condition.**
  - **A unimodal condition can lead to *more production gains* than a bimodal condition.**
- Relative improvement for unimodal condition likely explained by three supports: 1) lexical support, 2) active participation, 3) overnight consolidation.

CLINICAL RELEVANCE

- Instead of passive distributional learning approaches for adults, use procedures that allow **active engagement** with target stimuli & **KR feedback.**
  - Direct applications to accent modification therapy for acquiring non-native speech sounds.
  - Possibly also applicable to improving perception and production in children with perceptual deficits associated with speech sound disorder.

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