# Integration of somatosensory and auditory information in vowel production


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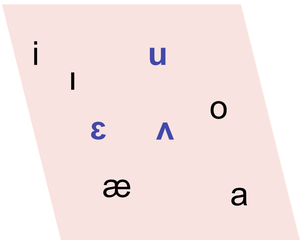
## Background

Articulatory plans to reach vowel targets are updated throughout life by monitoring auditory and somatosensory feedback. Articulation is adjusted when there is a mismatch between observed and expected feedback from either source (Houde & Jordan 2002, Tremblay, Ostry, & Shiller 2003), but the amount of adjustment is smaller than the mismatch (Katseff, Johnson & Houde 2010). Here, we ask whether the amount of compensation for altered auditory feedback is mediated by salience of somatosensory feedback.

California English

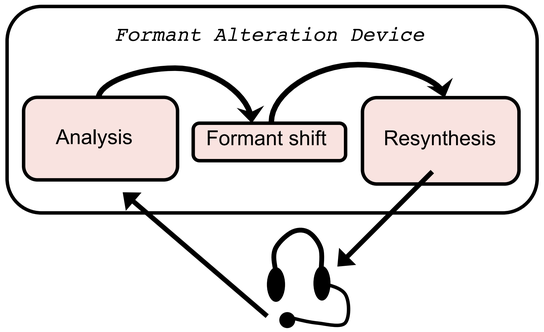



somatosensory feedback

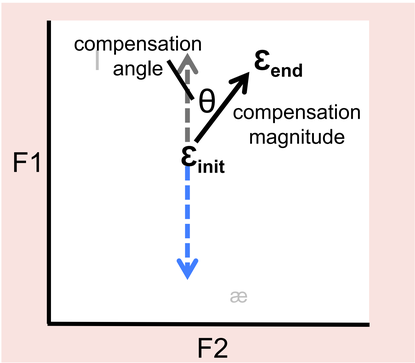
| | ʌ | ɛ | u |
|---|---|---|---|
| lip rounding | no | no | yes |
| palatal contact | minimal | moderate | moderate |

If somatosensory feedback is **more important** to vowel targets when it is **more salient**, then compensation for an auditory feedback shift of fixed size should be greatest for /ʌ/ and least for /u/.

## Procedure



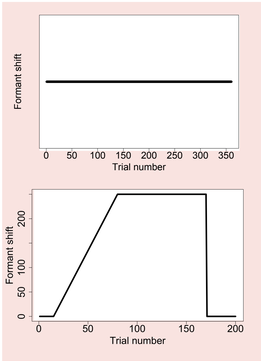

**Measurement**




### Methods

N=20 subjects.
Two days.

Instruction: produce the CVC word that appears on a computer screen.




Day 1: No feedback shift.
Stimuli: 360 $C_1VC_2$ words + nonwords.
($C_1$={b, d, r, h} and $C_2$={d, g}).

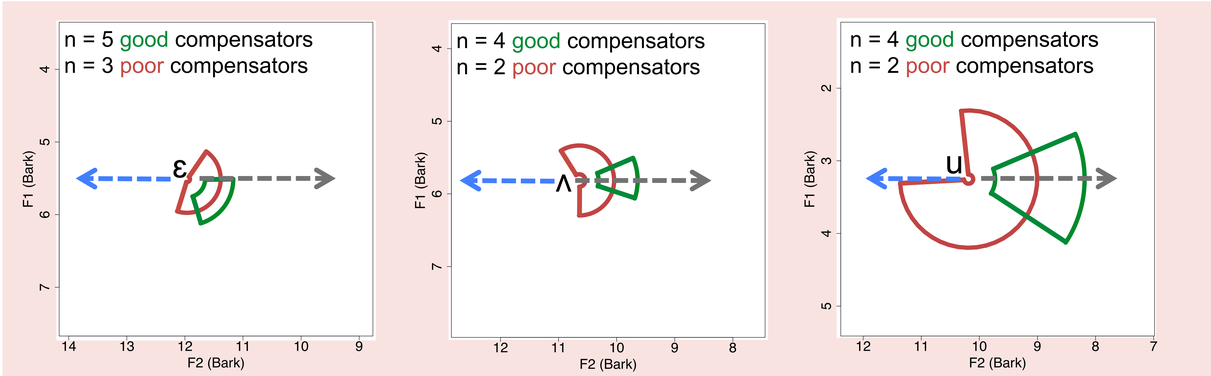
Day 2: Ramped feedback shift.
Stimuli: 200 $C_1VC_2$ words + nonwords.
/ɛ/ condition: head, bed, dead
/ʌ/ condition: hud, bud, dud
/u/ condition: bood, rude, food

## Results

Due to significant individual variation, subjects were split into two groups:

*Good compensators* = talkers whose formants changed at least 2*std. deviation of baseline vowel region
*Poor compensators* = talkers whose formant production changed by less than this amount.

Wedges encompass 95% of the last 30 vowel productions with maximum formant shift.




Good compensators reacted differently to the three vowel conditions: compensation magnitude was *greatest* for shifts in /u/ formant feedback, with several subjects appearing to compensate nearly completely. Compensation angle was statistically different from 0 degrees for /ɛ/, but *not* for /ʌ/ or /u/.

Poor compensators appeared to wander around their baseline vowel regions in all three conditions, as indicated by the wide range of angles in this group; their compensation was not directed.

## Discussion

Because compensation for shifts in /ʌ/ feedback was neither larger in magnitude nor more direct than compensation for shifts in /u/ feedback, we suggest that salient palatal and lip somatosensory feedback does **not** lead to increased weighting of somatosensory relative to auditory feedback. This finding suggests that we should not expect vowels with salient somatosensory feedback to be more stable over time either within or across individuals.

It is possible that the large compensation found for /u/ is due to the large size of the /u/ region in California English: perhaps it is more natural to compensate for altered feedback that falls within the same vowel region. This account predicts that speakers of languages with smaller /u/ regions would compensate less for altered /u/ feedback than do California English speakers.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