

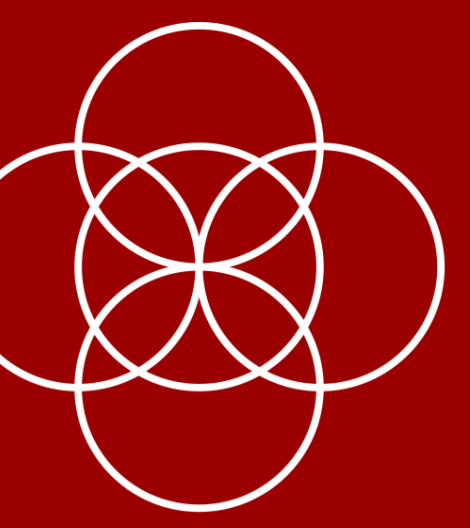


Lexical tone and arbitrary f0 are co-planned with segmental gestures

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When is lexical tone incorporated into motor planning?

- Hypothesis 1: Lexical tone is **planned concurrently** with segments^[1, 2, 3]
- Hypothesis 2: Lexical tone is **planned after segments**^[4, 5, 6]

Altered auditory feedback provides new lens on question

The same movement can be simultaneously adapted in opposing directions if **concurrently planned** with differentiating movements^[8,9]

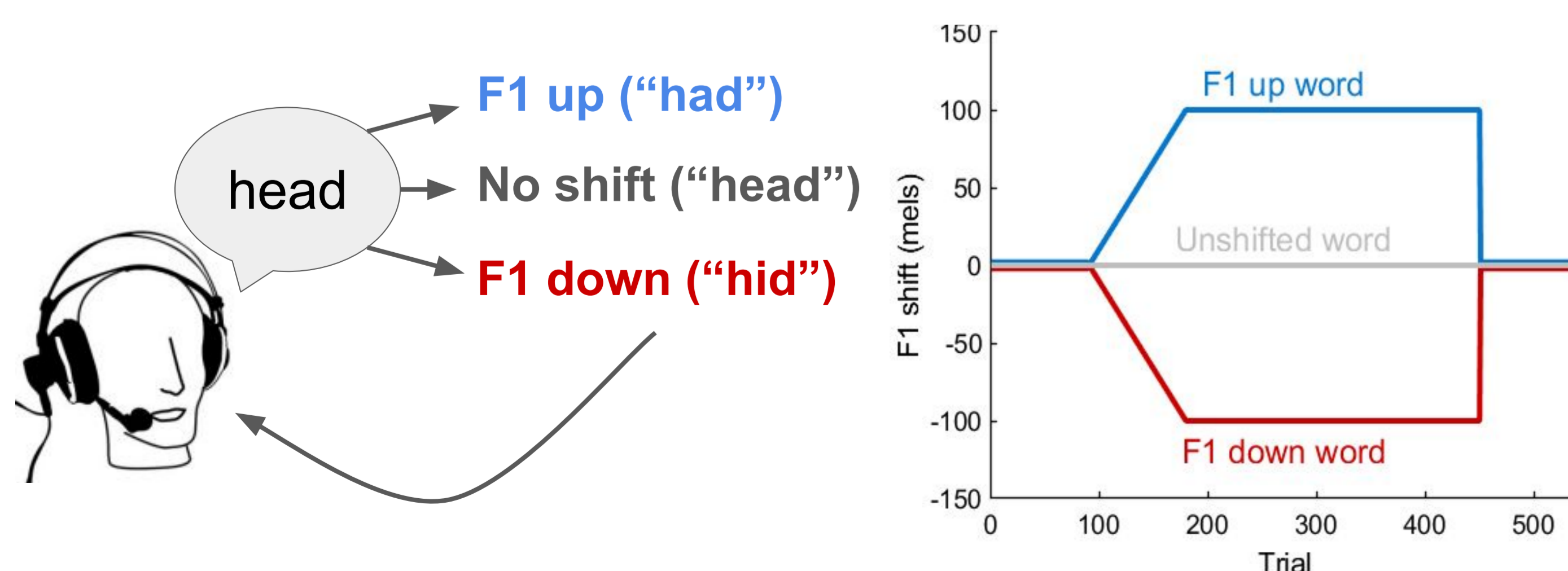
Experiment 1: Mandarin (n = 12)

Word	飞 /fei ¹ / “fly”	肥 /fei ² / “fat”	费 /fei ⁴ / “cost”
F0	High level	Rising	Falling

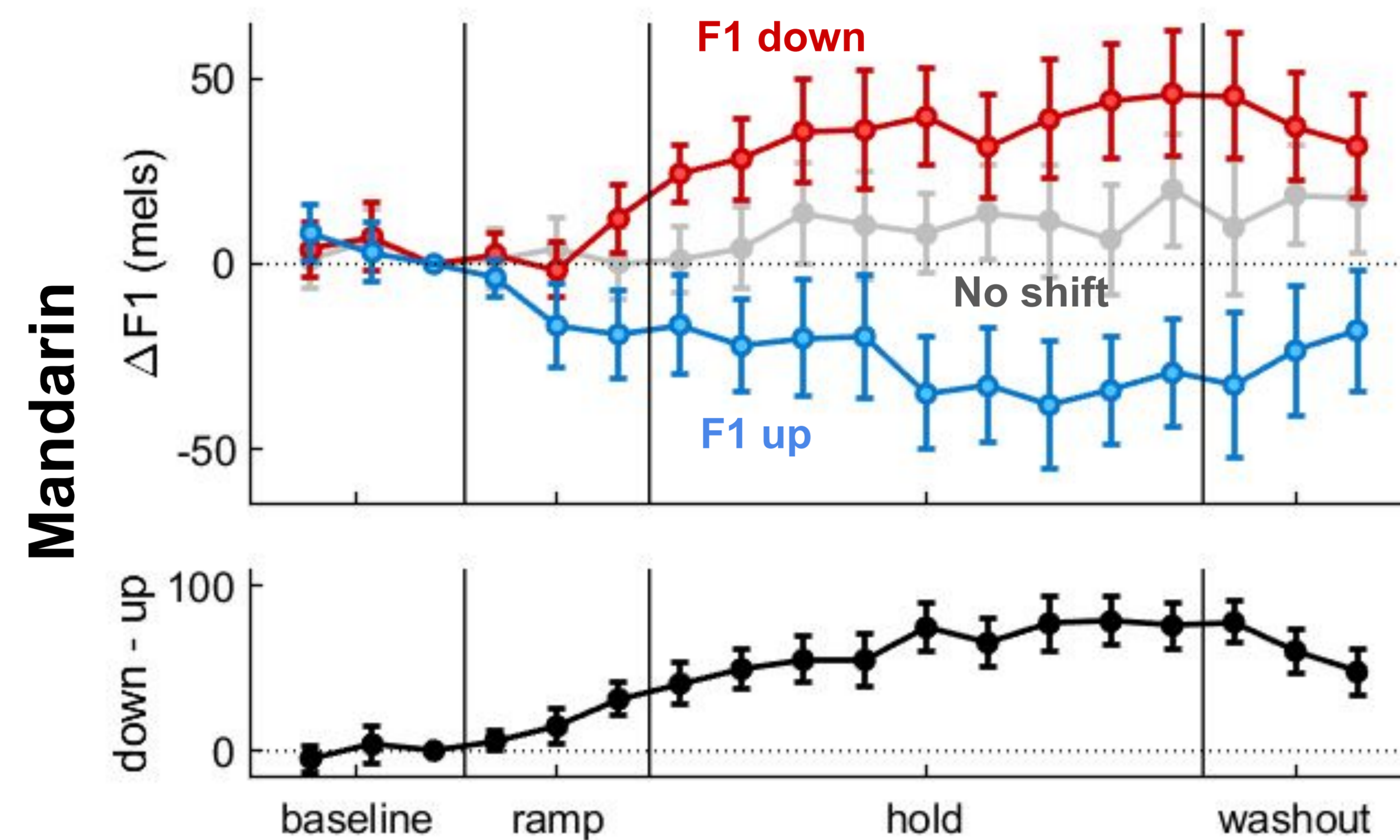
Experiment 2: Arbitrary f0 in English (n = 16)

Word	head (L)	head (M)	head (H)
F0	Habitual f0	+3 st	+6 st

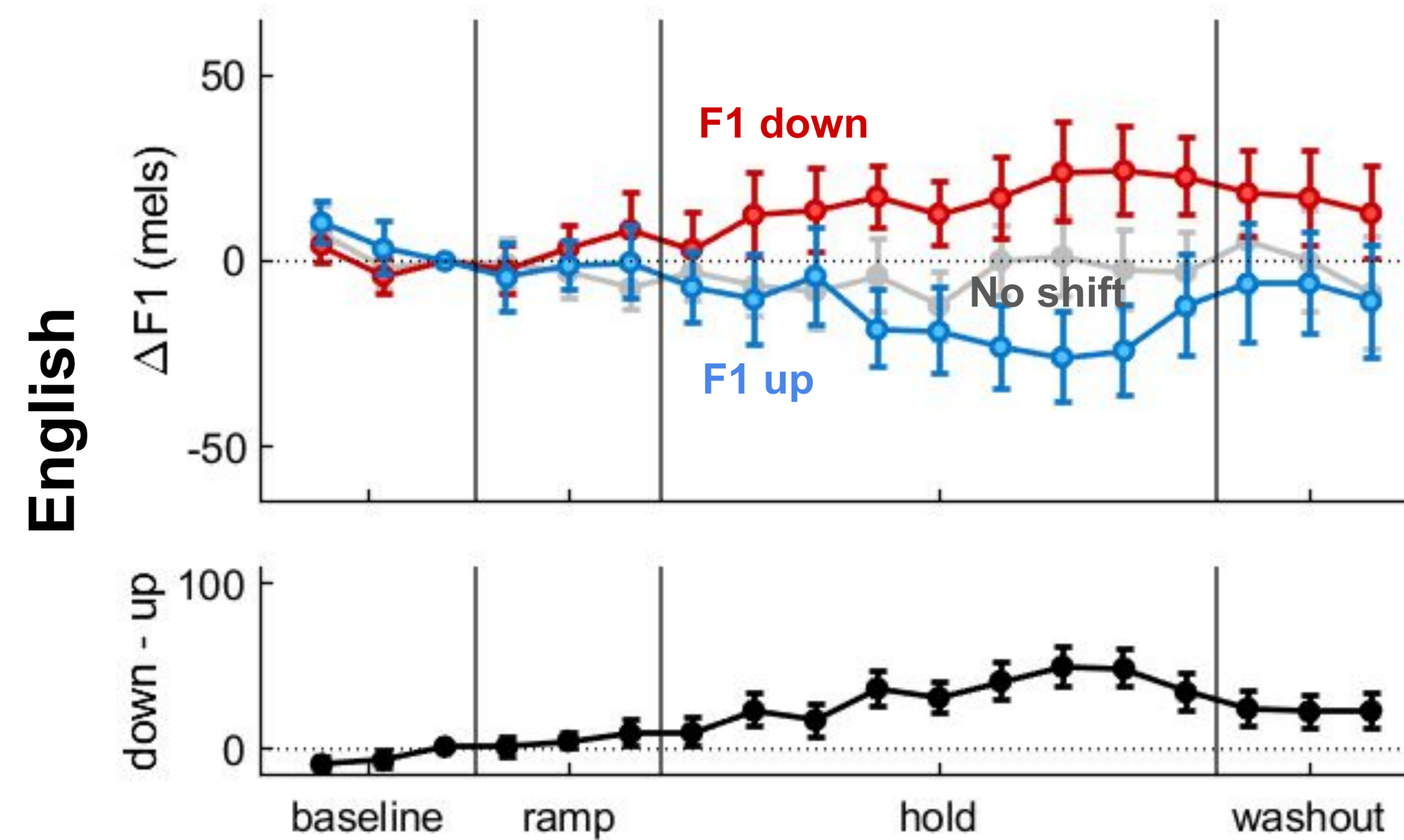
Three simultaneous perturbations



Mandarin and English speakers show simultaneous, opposing adaptation of F1



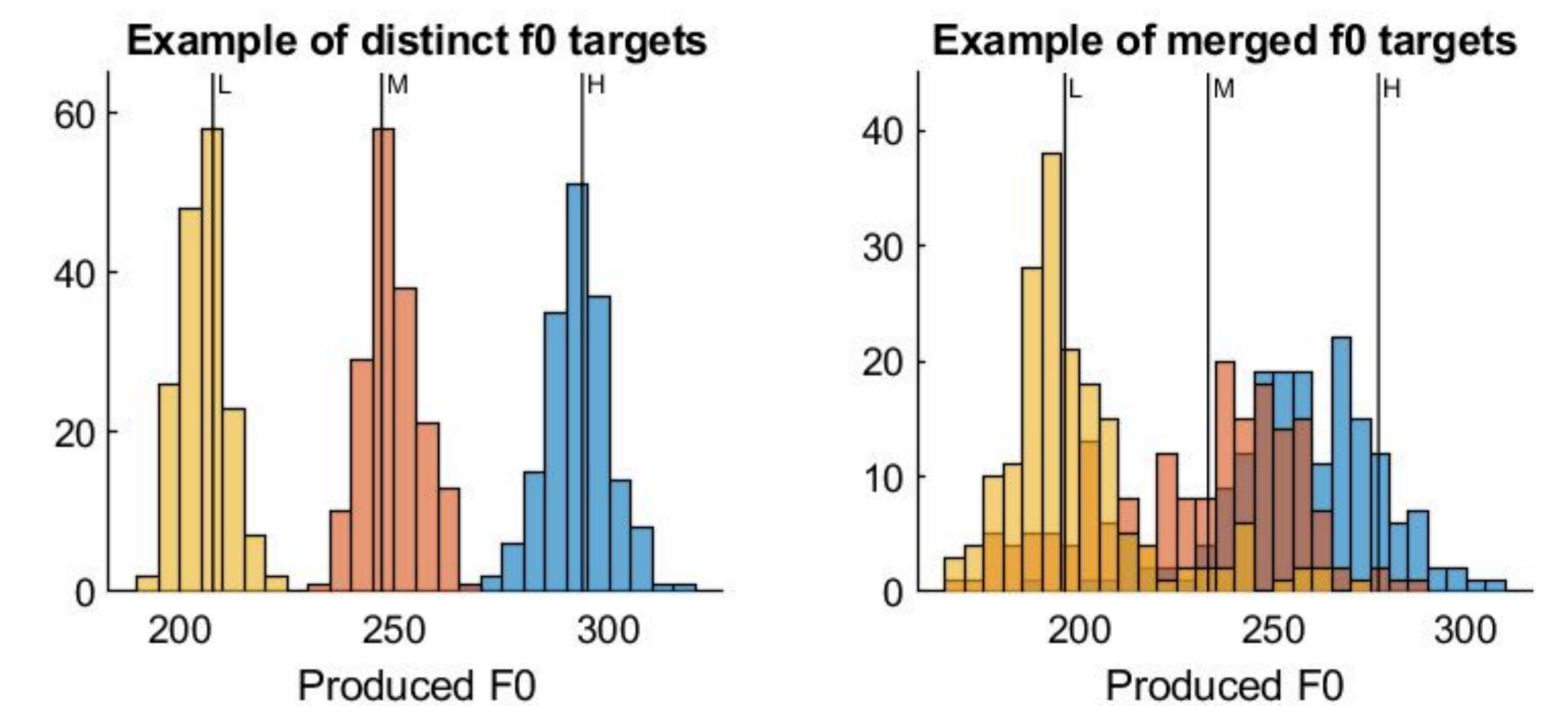
- Mandarin speakers show opposing adaptation, indicating **concurrent planning** of lexical tone and segments



- English speakers also **show opposing adaptation**, with arbitrary f0 as differentiating movement

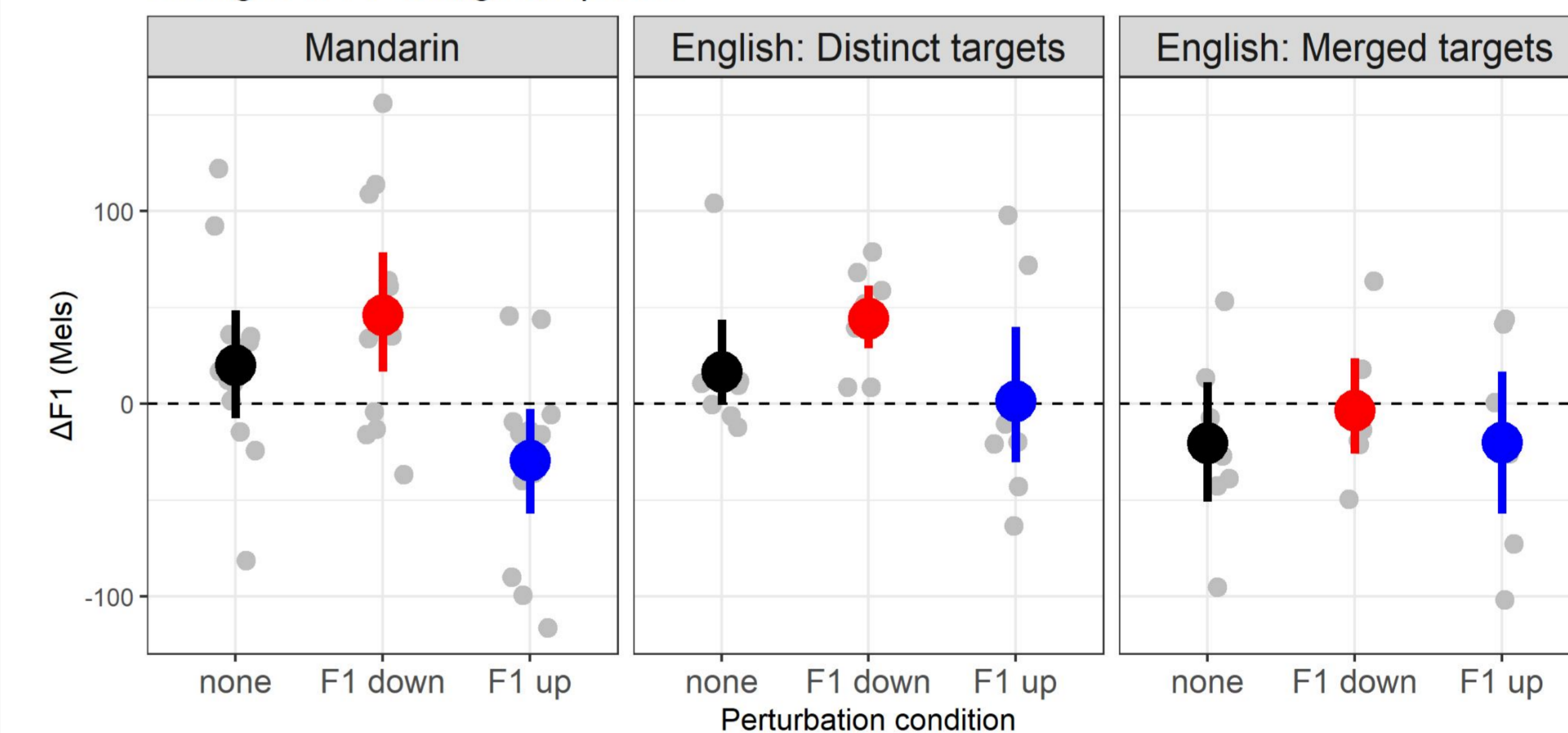
English speakers: possible effect of ability to produce distinct f0 targets

- Seven English participants had difficulty consistently producing distinct L, M, H targets



- More adaptation in speakers with three distinct f0 targets
- May suggest adaptation to perturbation to physical link between tongue height and laryngeal position

Changes in F1 during hold phase



tl;dr: lexical tone is planned at the same time as segments. More investigation is needed for f0 control in nontonal contexts.