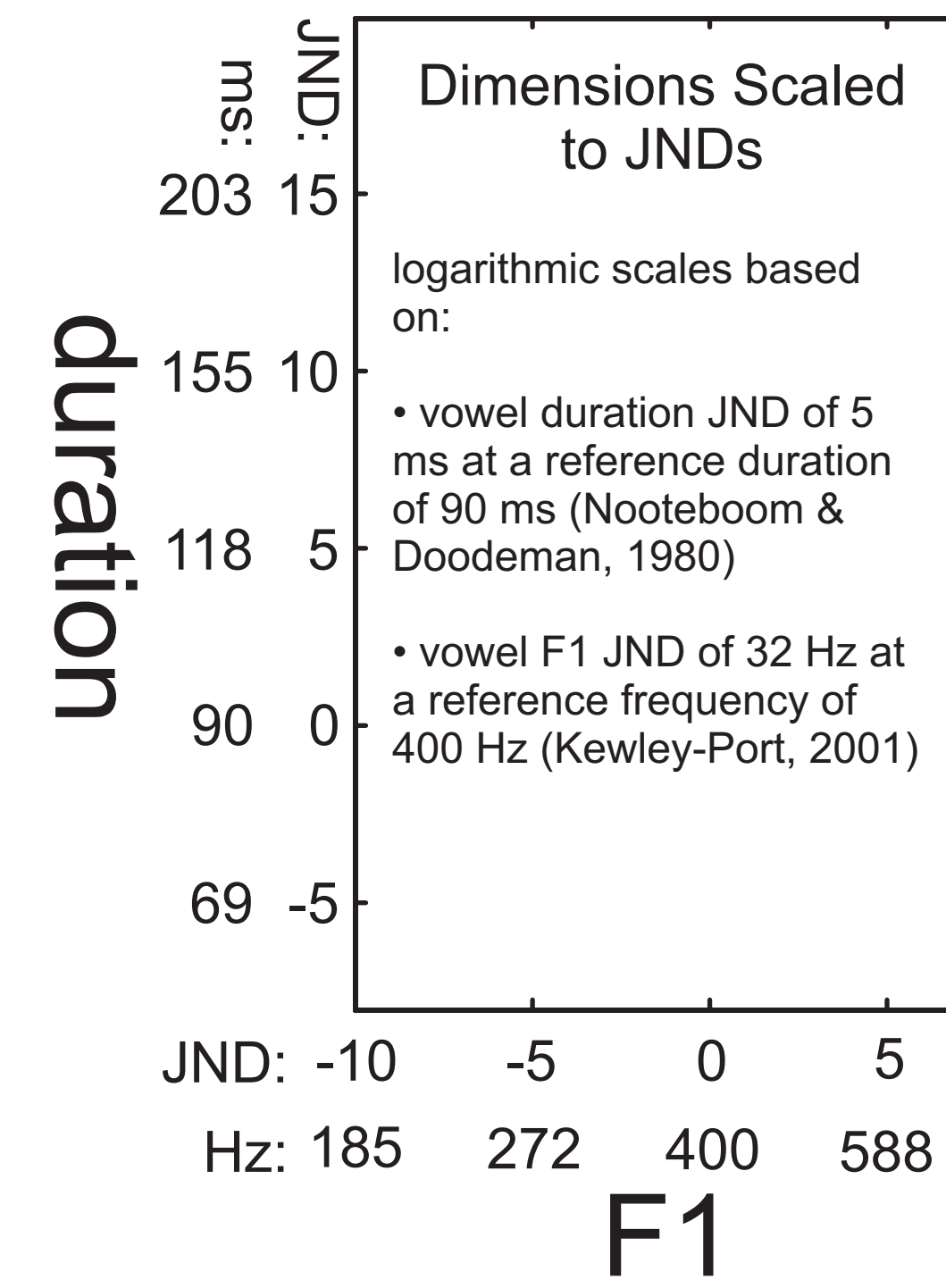
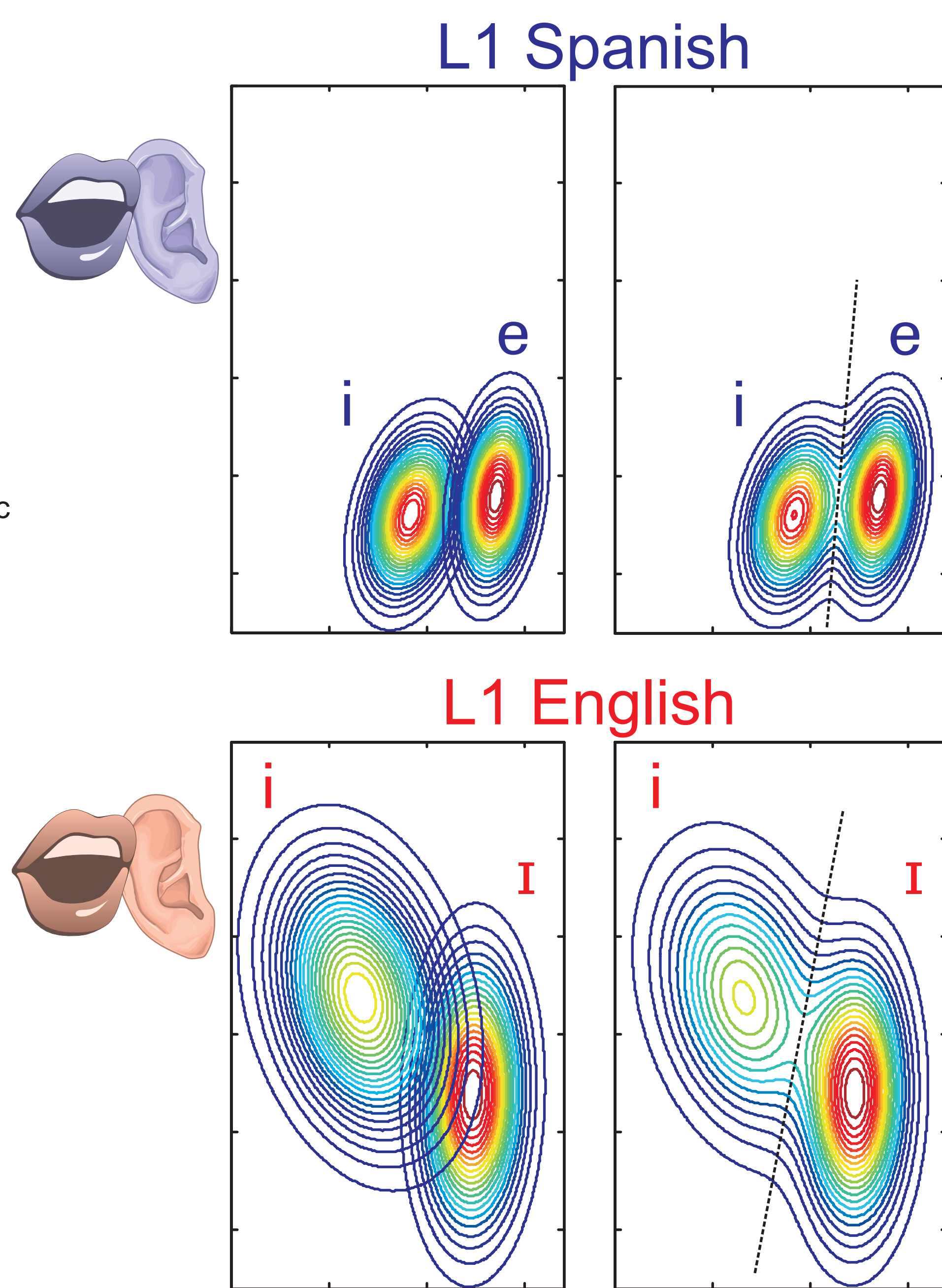


Principles for a Quantitative Speech Learning Model

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L1 learning

- Infants
 - begin tabula rasa
 - exposed to speech sounds produced by adults
 - sum of multidimensional distributions of acoustic properties
 - posit categories based on sum of distributions
 - peaks: prototypes
 - valleys between peaks: boundaries
 - associate categories with differences in meaning
 - category formation precedes category labelling
 - production categories based on perception categories

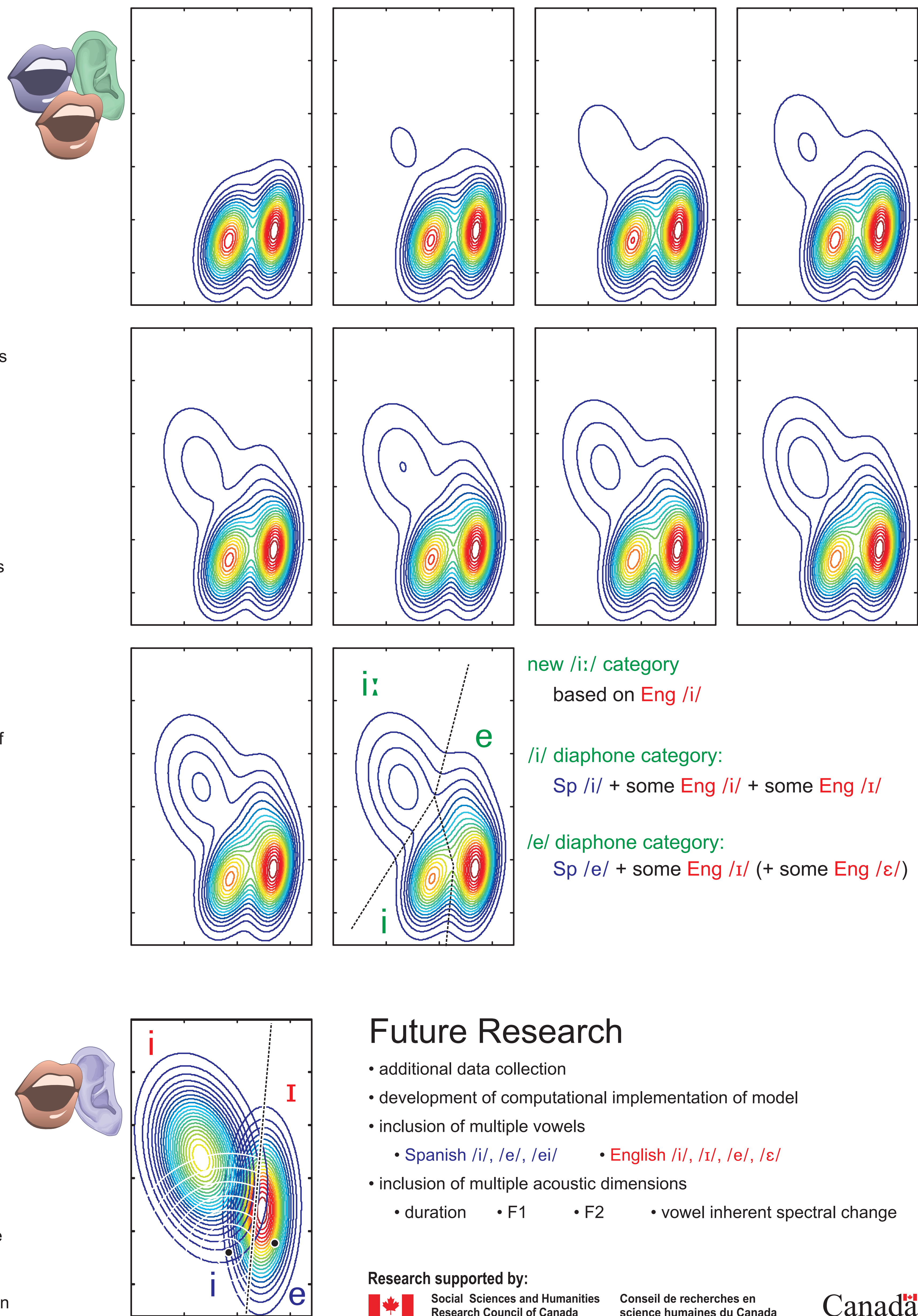


Data

- 10 female monolingual Spanish speakers (Vitoria-Gasteiz, The Basque Country, Spain)
 - 10 recordings each of /bipa/, /bepa/
- 13 female monolingual English speakers (Ottawa, Ontario, Canada)
 - 4 recordings each of /bit/, /bit/ (English data in same context as Spanish to be collected)

L2 learning

- L2 learners
 - begin with an L1 perception system
 - exposed to speech sounds produced by L2 speakers
 - sum of multidimensional distributions of acoustic properties
 - posit categories based on sum of distributions
 - same mechanisms as for L1 learning
 - no dimension-specific stipulations
 - cf. Bohn's Desensitisation Hypothesis: desensitisation to spectral differences
 - cf. Escudero & Boersma (2004): no categories on the duration dimension
 - slow track
 - number of instance of L2 sounds heard is small compared to past exposure to L1 sounds
 - perceptual inertia
 - distributions of L2 sounds gradually added to distributions of L1 sounds
 - phenomena specified qualitatively in Flege's SLM emerge from first principles of distribution-based learning
 - "new" L2 categories have properties which match those of native speakers of the L2
 - e.g., prototypical values for new /i:/ category
 - "similar" diaphone categories develop properties which are a mixture of the L1 and L2 category properties
 - e.g., increase in duration range for /e/ diaphone
 - fast track
 - instances of L2 sounds are assimilated to L1 sounds
 - sounds assimilated to an L1 sound but further from the L1 prototype are more noticeable as deviant members of the L1 category (Best's PAM)
 - multi-dimensional category-goodness assimilation
 - example:
 - multidimensional category-goodness assimilation of English /i/ and /ɪ/ to Spanish /i/
 - Spanish /i/—/e/ boundary is upper F1 boundary for assimilation of higher-F1 instances of English vowels to Spanish /i/
 - no Spanish vowel category, of similar or lower F1, is longer than Spanish /i/, therefore no upper boundary on assimilation of longer-duration instances of English vowels to Spanish /i/
 - instances of long-English /i/ are farther from the Spanish /i/ prototype than any instances of English /ɪ/ or low-F1-English /i/ assimilated to Spanish /i/
 - instances of long-English /i/ are very far from the Spanish /i/ prototype and are therefore immediately noticeable
 - listeners notice the duration difference and (consciously) use Spanish [i] and [i:] to differentiate English /i/ and /ɪ/ in perception and production



Future Research

- additional data collection
- development of computational implementation of model
- inclusion of multiple vowels
 - Spanish /i/, /e/, /ei/ • English /i/, /ɪ/, /e/, /ɛ/
- inclusion of multiple acoustic dimensions
 - duration • F1 • F2 • vowel inherent spectral change

Research supported by:

Social Sciences and Humanities Research Council of Canada Conseil de recherches en science humaines du Canada

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