Phonological Encoding and the Nature of Segments

Karee Garvin & Eric Wilbanks

University of California, Berkeley

LabPhon – July 6, 2020

Background

Background

- Recent studies have brought the nature of segments into focus.
- While the phone has served as a useful construct for research in both phonetic and phonological theory,
  - There is a trend both in speech processing and theoretical phonology away from segments towards both syllables and smaller units such as subsegments or gestures.

Background

- Support for syllables in speech processing and phonological theory:
  - Hickok (2014) and Oganian & Chang (2019) both demonstrate the necessity of syllables in speech encoding.

Background

- Support for syllables in speech processing and phonological theory:
  - Hickok (2014) and Oganian & Chang (2019) both demonstrate the necessity of syllables in speech encoding.
  - Hickok (2014) further advocates for the role of the syllable in speech production.

Background

- Support for syllables in speech processing and phonological theory:
  - Hickok (2014) and Oganian & Chang (2019) both demonstrate the necessity of syllables in speech encoding.
  - Hickok (2014) further advocates for the role of the syllable in speech production.
  - Walker & Proctor (2019) illustrate that differences in blending strength between rhotics and front and back vowels account for differences in syllable weight in American English rhymes.

Background

- Support for features, gestures, and subsegments in speech processing and phonological theory:
  - Walker & Proctor (2019) further explain the utility in subsegmental representations for accounting for such differences in coarticulation.

Background

- Support for features, gestures, and subsegments in speech processing and phonological theory:
  - Walker & Proctor (2019) further explain the utility in subsegmental representations for accounting for such differences in coarticulation.
  - Lionnet (2017) argues that subfeatures are able to account for phonological patterning that segments cannot capture.

Background

- Support for features, gestures, and subsegments in speech processing and phonological theory:
  - Walker & Proctor (2019) further explain the utility in subsegmental representations for accounting for such differences in coarticulation.
  - Lionnet (2017) argues that subfeatures are able to account for phonological patterning that segments cannot capture.
  - Papers in Q Theory demonstrate that subsegmental representations are better able to capture contour segments and a broader range of attested phonological patterns (among others, Shih & Inkelas, 2019).

Background

- Support for features, gestures, and subsegments in speech processing and phonological theory:
  - Walker & Proctor (2019) further explain the utility in subsegmental representations for accounting for such differences in coarticulation.
  - Lionnet (2017) argues that subfeatures are able to account for phonological patterning that segments cannot capture.
  - Papers in Q Theory demonstrate that subsegmental representations are better able to capture contour segments and a broader range of attested phonological patterns (among others, Shih & Inkelas, 2019).
  - In speech processing, Mesgarani et al. (2014) demonstrate that patterns of neural encoding of speech are best accounted for through features, rather than segments.

Background

- In opposition to studies advocating for syllables and subsegments as crucial units of representation:

Background

- In opposition to studies advocating for syllables and subsegments as crucial units of representation:
  - Kazanina et al. (2017) argues that when analyzed from a top-down perspective, segments are necessary in accounting for both attested phonological patterning and behavioral studies of phonological processing.

Background

- In opposition to studies advocating for syllables and subsegments as crucial units of representation:
  - Kazanina et al. (2017) argues that when analyzed from a top-down perspective, segments are necessary in accounting for both attested phonological patterning and behavioral studies of phonological processing.
  - In particular, Damian & Dumay (2009) demonstrate that repeated phonemes in adjective noun pairs (e.g., "blue crab") have a facilitatory effect on response time regardless of whether the phones occur in the same syllable position.

Question

Question

- Facilitation due solely to **abstract phonological encoding** predicts:
  - Similar degree of facilitation for different phonemes/positions

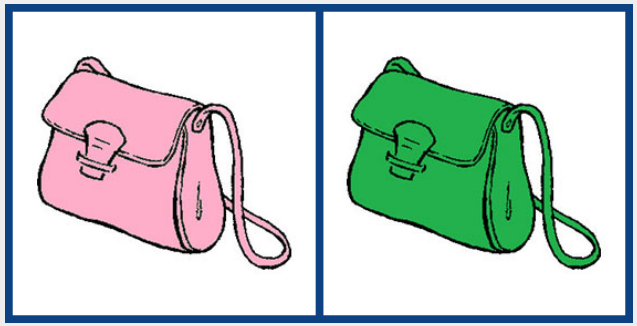
Question

- Facilitation due solely to **abstract phonological encoding** predicts:
  - Similar degree of facilitation for different phonemes/positions
- Facilitation due to **sub-phonemic encoding** predicts:
  - Variability in degree of facilitation for different phonemes/positions

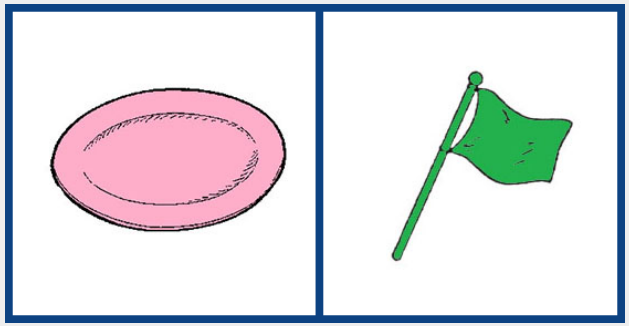
Experiment

Experiment

- We conducted a picture naming task following Damian & Dumay (2009) to measure naming latency of color-noun pairs that varied on whether:
  - Phonemes were overlapping ("**p**ink **p**urse") or non-overlapping ("**g**reen **p**urse")



  - Phoneme target noun was initial ("**p**ink **p**late") or final ("**g**reen fla**g**")



Experiment

- Furthermore, to test whether allophonic variability affected the facilitatory effect, we added stimuli with [ɹ][1] in related and unrelated pairs and in initial and final position
  - [ɹ] is a good test case for the role of allophonic variation priming as [ɹ] has been found to vary depending on both position and vocalic environment (Delattre & Freeman, 1968; Westbury et al., 1994; Mielke et al., 2010)

[1] Damian & Dumay (2009) use stimuli with target/prime [b], [g], and [p].

Results

Results

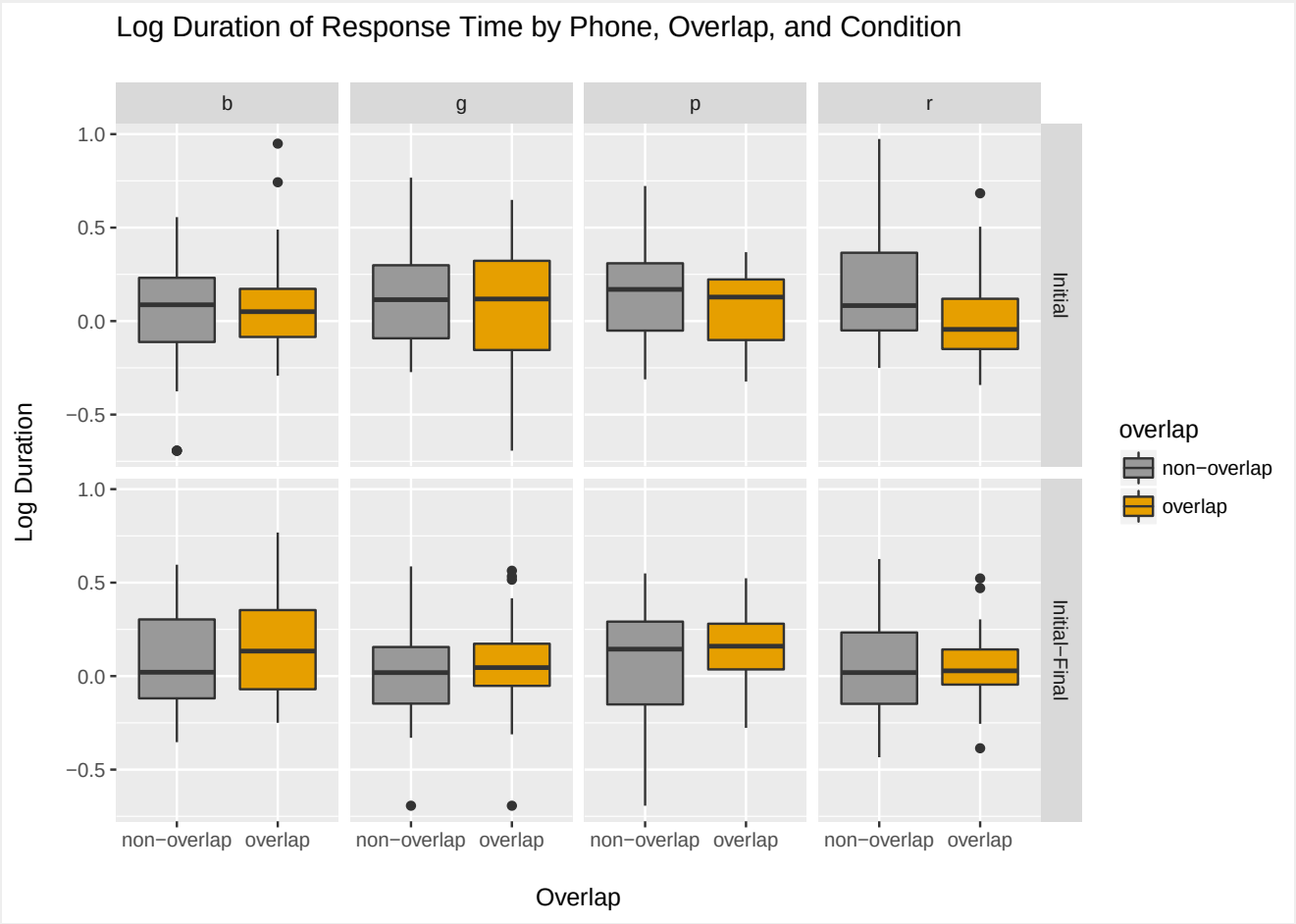


Figure: Model-Predicted Log Duration of Response Time by Phone, Overlap, and Condition

Results

- Overall, significant facilitatory effect (lower RT latencies) in overlapping than non-overlapping pairs for initial positions (e.g., '**p**ink **p**urse'
- No significant facilitatory effect for overlapping pairs in initial-final positions (e.g., '**g**reen fla**g**').
- Significant phoneme-by-phoneme variation in strength of priming effect in initial position.

Conclusions

Conclusions

- We find facilitatory priming between repeated phonemes in initial positions, but not between phonemes in different positions (initial-final).
- We find significant variation in the strength of this priming effect.
- These results cannot be completely accounted for by abstract phonological analyses.
- A featural or gestural based model that allows phonemes to vary in their similarity and priming can account for the variability we observe.

References

Damian, M. & Dumay, N. (2009). Exploring phonological encoding through repeated segments. *LANGUAGE AND COGNITIVE PROCESSES*, 24, 685–712.

Delattre, P. & Freeman, D. (1968). A dialect study of American R's by X-ray motion picture. *Linguistics*, 44, 29–68.

Hickok, G. (2014). The architecture of speech production and the role of the phoneme in speech processing. *Language, Cognition and Neuroscience*, 29(1), 2–20.

Kazanina, N., Bowers, J., & Idsardi, W. (2017). Phonemes: Lexical access and beyond. *Psychonomic Bulletin Review*, 25.

Lionnet, F. (2017). A theory of subfeatural representations: The case of rounding harmony in laal. *Phonology*, 34, 523–564.

Mesgarani, N., Cheung, C., Johnson, K., & Chang, E. F. (2014). Phonetic Feature Encoding in Human Superior Temporal Gyrus. *Science (New York, N.Y.)*, 343(6174), 1006–1010.

Mielke, J., Baker, A., & Archangeli, D. (2010). Variability and homogeneity in American English /ɹ/ allophony and /s/ retraction. In C. Fougeron, B. Kühnert, M. D'Imperio, & N. Vallée (Eds.), *Variation, Detail, and Representation (LabPhon 10)* (pp. 699–719). Berlin: Mouton de Gruyter.

Oganian, Y. & Chang, E. (2019). A speech envelope landmark for syllable encoding in human superior temporal gyrus. *Science Advances*, 5.

Shih, S. & Inkelas, S. (2019). Subsegments and the emergence of segments. *Proceedings of the Linguistic Society of America*, 4, 37.

Walker, R. & Proctor, M. (2019). The organisation and structure of rhotics in american english rhymes. *Phonology*, 36, 457–495.

Westbury, J. R., Turner, G., & Dembowski, J. (1994). *X-Ray Microbeam Speech Production Database User's Handbook*. Technical report.

Thank You!

Questions? Suggestions?