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Computational Modeling of Spoken Language Processing: A hands-on tutorial

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Haskins Laboratories

Computational Modeling of Spoken Language Processing: A hands-on tutorial

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Plan

- Module 1: Introduction, About TRACE
- Module 2: Tour of jTRACE
- Module 3: Classic simulations
- Module 4: Scripting et al.
- Module 5: Linking hypotheses
- Module 6: Lab time, Q&A, one-on-one

Module 4

- Scripting batches of simulations
- Modeling a complete experiment.

jTRACE Scripting : motivations

- Scripting permits execution of batches of related simulations
- Replication of complete experiment design
- Investigation of parameter space, ranges of analysis settings

jTRACE Script : schematic

- Make initial parameter settings
- Iterate over a range of values
- For each iteration, run a simulation
  - (optionally) perform analysis operations
  - Output data to files and/or open new simulation window.

Script #1

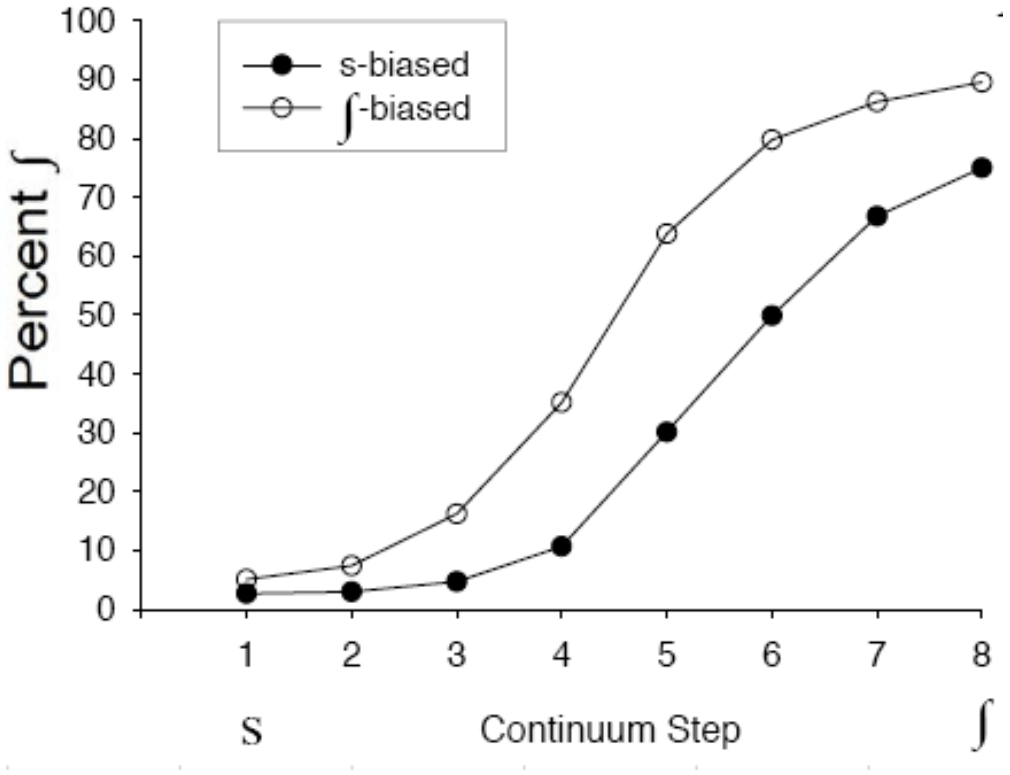
- Select basic-script > load template
- Instruction 3 > Iterator > Incrementing-Value > alpha.ip > from 0.2 to 1 in 3 steps
- Add 4 nodes to the iterator instructions.
- Action 1 > set-a-parameter > alpha.WP > 0.2
- Action 2 > new-window
- Action 3 > save-graph-to-png > file …
- Run

Script #1 (con't)

- Results
  - 3 windows opened showing effect of varying amounts of bottom-up excitation
  - 3 image files

Script #2: Ganong experiment

- Recall: Categorical perception of word-final phoneme is shifted by lexical context.
- Challenge: replicate the results of the Ganong experiment in TRACE.



[Figure 1; Pitt & Samuel (2006, jep:hpp)]

Ganong expt: refresher

- 8-point continuum created between /s/ and /sh/.
- Attached to two lexically biased context, e.g. b^? (b^s-b^S) and r^? (r^s-r^S)
- Subject is required to classify the phoneme as /s/ or /S/ over many trials.

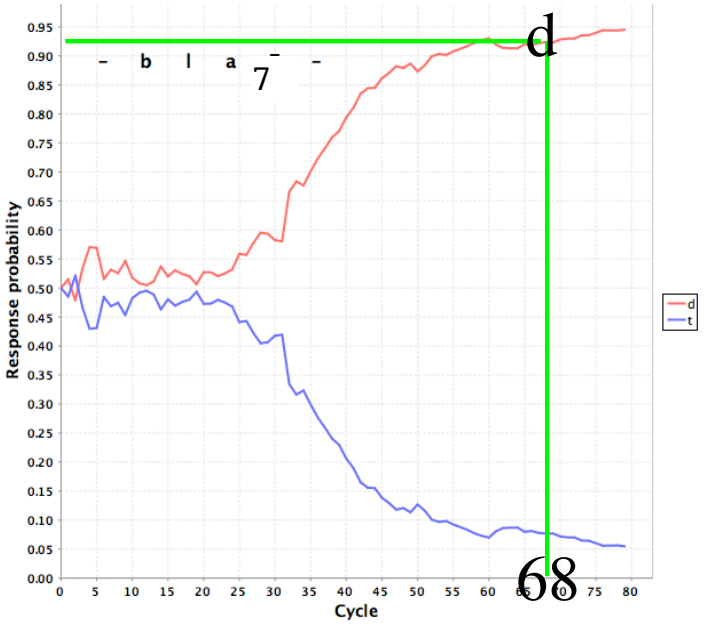
Ganong script: design

- Create a 7-point phoneme continuum between /t/ and /d/.
- Select /t/-bias and /d/-bias words (e.g.) from lexicon:
  - t-bias: bru?, kar?, bis?, bus?
  - d-bias: bl^?, bri?, Sil?, spi?
- Run a TRACE simulation on each step of the phoneme continuum.
- Use a decision rule over phoneme response probabilities to model subject response.
- Repeat the same stimuli 25 times with model stochasticity to approximate individual differences.

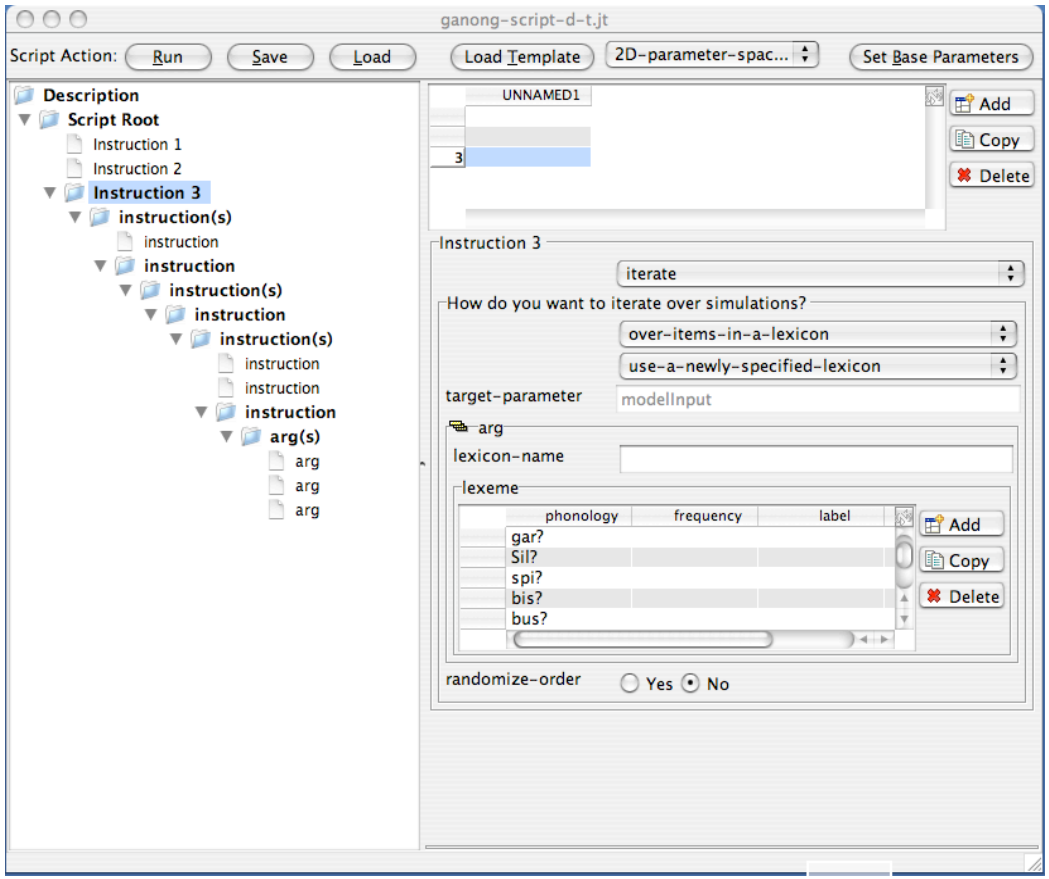
Ganong script - write output

- For each simulation, a response probability graph is generated.
- Use a response threshold to record which phoneme (/t/ or /d/) is detected, and at which cycle.
  - e.g. continuum pt 6:

    `bla6  d  68`
- Analyze that data.

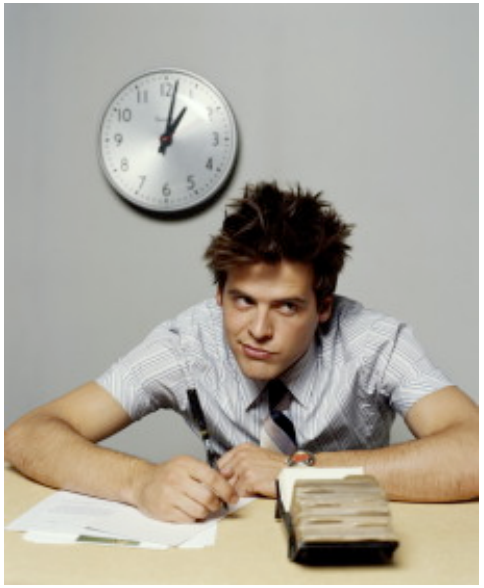


Writing the jTRACE script



see script...

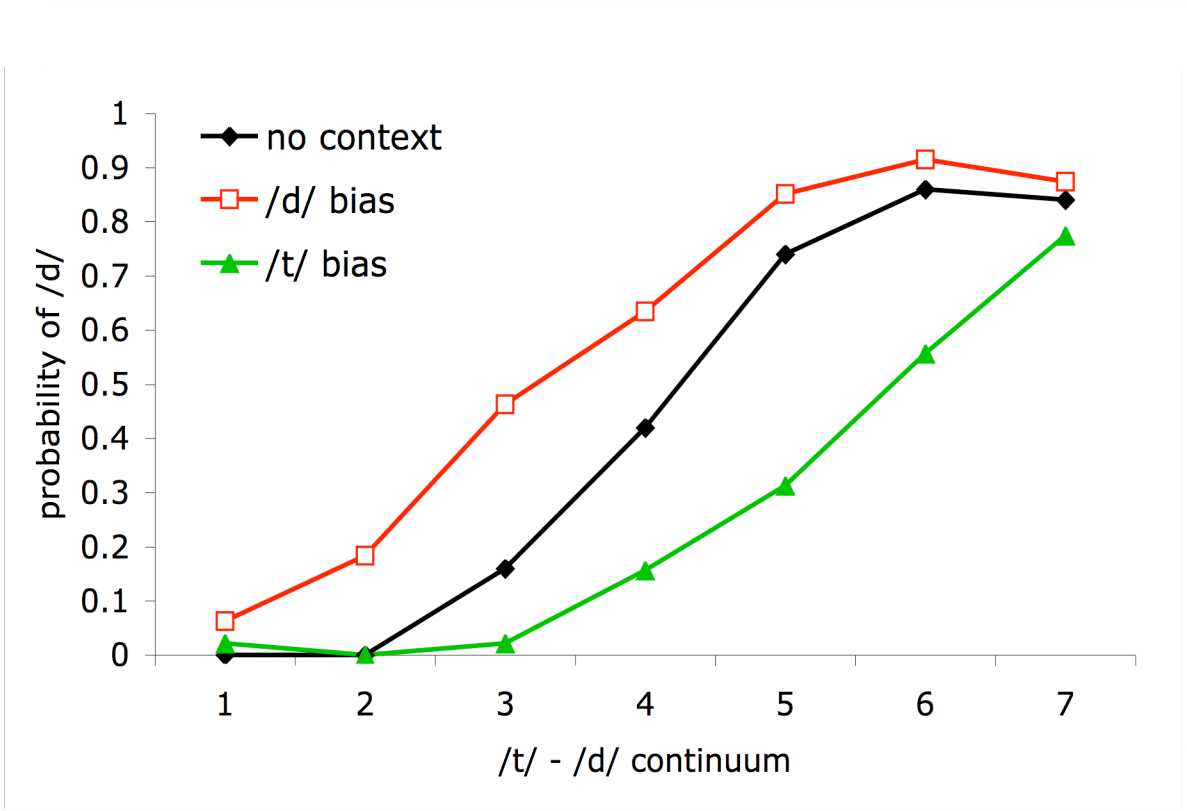
Ganong script - running...



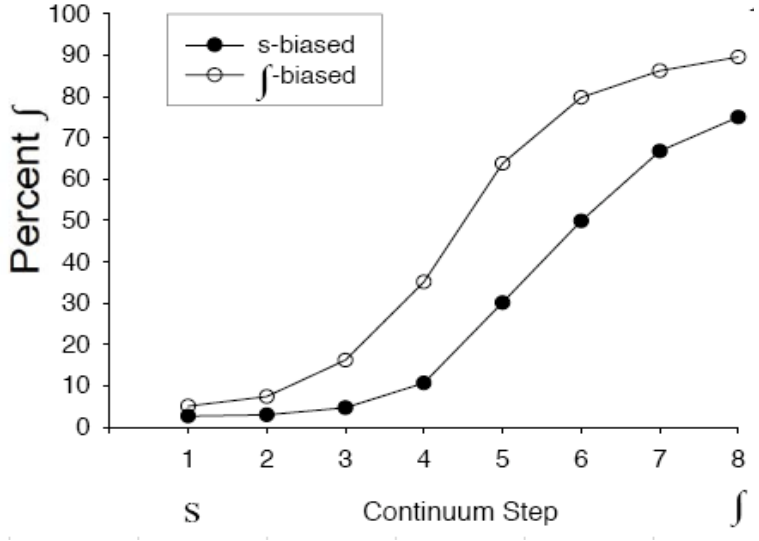
- Each simulation takes a few seconds.
- This simulation has 20*7*25=3500 simulations.

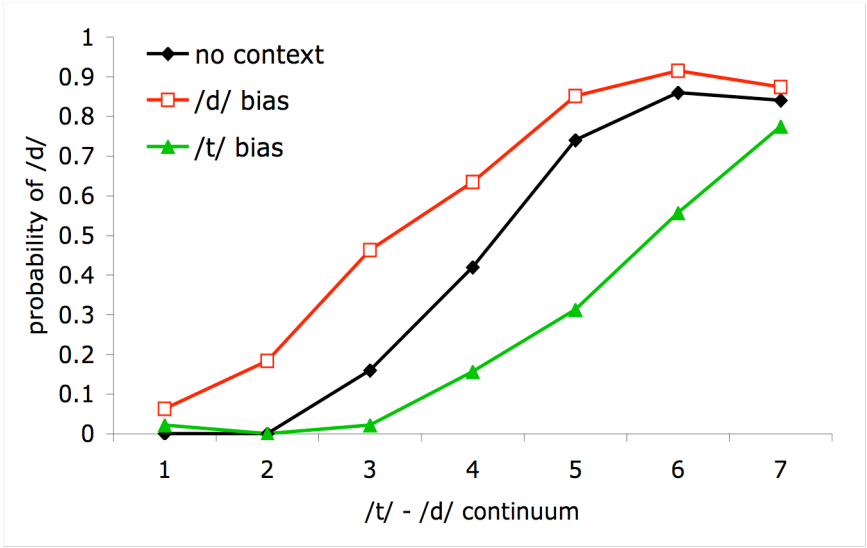
Results and analysis

- Calculate the probability of a /d/ responses at each continuum point, for each type of context.
- Result is a clear effect of context on phoneme identification.



- Comparison of behavioral Ganong plot (left) to the TRACE Ganong plot (right).





What we showed

- In addition to showing the Ganong effect in individual simulations, TRACE can simulate the design of an entire behavioral experiment.
- Lexical-to-phoneme feedback is the key mechanism for achieving this result.
- This modeling work can be prepared in jTRACE in a short time.

By request: Phoneme editor

- Note: phoneme editor is a recent addition and has bugs.
- Allows the creation of new phonemes, complete phonologies, or modification of existing roster.
  - modify feature vectors via a table of numeric entries.
  - see outcome by switching to input, sim panels.

Phoneme editor features

- Duration scalar: ability to modify the temporal spread of a particular phoneme.
- “Allophonic” relation: choose to mute out phoneme competition between any pair of phonemes.
- Hands-on examples:
  - edit the /a/ phoneme and see result.
  - add a shortened allophone of /a/ and see result.

Next: Module 5

- Linking hypotheses
- Success and failure in modeling