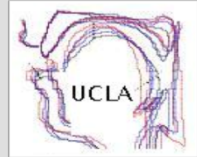


Experimental evidence for phoneme-level inhibition in spoken word recognition

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Background

- Popular models of spoken word recognition differ on phoneme-level inhibition:
- TRACE – YES phoneme-level inhibition**
 - That is, automatic competition between phonemes at a pre-lexical level of representation (McClelland & Elman, 1986)
- Shortlist/Merge – NO phoneme-level inhibition**
 - Rather, hearing one phoneme also activates other similar phonemes in a **gradient** manner (Norris, 1994; Norris, McQueen, & Cutler, 2000)

Research Questions

- Can we find experimental evidence for phoneme-level inhibition?
- In other words, will hearing a sound make it harder for participants to process other similar sounds soon after?

Experiment 1 – Auditory Lexical Decision

- To demonstrate **phoneme-level inhibition**, need to rule out two things:
 - Lexical competition**
 - May also inhibit responding (e.g., Hamburger & Slowiaczek, 1996)
 - Solution: Priming with isolated sounds instead of words
 - Post-lexical strategic processing**
 - That is, changes in RT due to strategies adopted by participants
 - Solution: Short inter-stimulus intervals (ISIs)
- Task: Auditory lexical decision
 - Participants heard target words/non-words preceded by isolated sounds as primes
 - Example:

*	→	[s]	...	'bus'	→	????
Visual		Prime	ISI	Target		Response
Fixation		(Auditory)	(Auditory)	(Auditory)		
- Manipulated 2 independent variables:
 - Relatedness** of the prime sound to the final phoneme of the target word
 - 3 within-subjects levels:
 - Identical (e.g., [s] ... 'bus') – expected to facilitate
 - Similar (e.g., [ʃ] ... 'bus') – expected to inhibit
 - Unrelated (e.g., [m] ... 'bus') – used as baseline

2. ISI (time between prime and target)

- 5 between-subjects levels
 - 50, 125, 250, 500, 1000 ms
- Stimuli:
 - Primes: [s], [ʃ], and [m]
 - Target Words: 24 CVC or CCVC, half ending in [s] and half ending in [ʃ].
 - Fillers: 24, 6 beginning with [s], 6 beginning with [ʃ], rest not containing the prime sounds.
 - Non-words: 48 CVC and CCVC
- Controls:
 - Counterbalanced so every word appeared equally in each Relatedness condition, in each ISI, and with each prime across participants.
 - Words matched for frequency/neighborhood density

Predictions

- If **YES phoneme-level inhibition**:
 - Similar condition should have **higher RTs** than Unrelated condition. Identical condition should not.
- If **NO phoneme-level inhibition**:
 - If any differences are found in RT, they should be Identical < Similar < Unrelated

Experiment 1 - Results

- 90 participants (18 per ISI)
- Figure 1. Mean RT in Experiment 1 by ISI and Relatedness.
- RT data: **YES phoneme inhibition** at ISI of 500 ms (significant) and 250 ms (trend).
- Accuracy: Participants were at ceiling in accuracy data.

Experiment 2 – Lexical Decision with Noise

- To reduce the ceiling effect by making the task harder.
- Lexical decision task same as Experiment 1, but white noise added to the target words.
- Two Signal-to-Noise Ratios: High (SN ratio = 14dB) and Low (SN ratio = 8dB).

Experiment 2 – Results

- 20 participants (12 for 250 ISI, 8 for 500 ISI)
- 250 ms ISI:
 - Figure 2. Mean RT in Experiment 2 at an ISI of 250 ms.
 - Figure 3. Mean error rate in Experiment 2 at an ISI of 250 ms.
- RT data: Pattern consistent with phoneme-level inhibition under High, but not Low SN ratio
- Accuracy data: No consistent pattern

- 500 ms ISI:
 - Figure 4. Mean RT in Experiment 2 at an ISI of 500 ms.
 - Figure 5. Mean error rate in Experiment 2 at an ISI of 500 ms.
- Interesting pattern:
 - High SN ratio – accuracy data, but not RT data consistent with phoneme-level inhibition
 - Low SN ratio – Opposite: RT data, but not accuracy data, consistent with phoneme-level inhibition.

Experiment 3 – Single Word Shadowing

- Motivation: Replicate the results in a different task
- Design similar to Experiment 1, but participants (n=49) repeated target words/non-words as quickly as possible.
- No effect in either accuracy or RT.
- May be due to floor effects relating to the speech motor planning and execution

Conclusions

- Words are recognized more slowly when preceded by Similar, but not Identical sounds (at ISIs of 500 ms, and perhaps 250 ms).
- With noise: recognition in Similar condition impaired differently depending on amount of noise (Speed/accuracy trade-off).
- These results, which cannot be attributed to lexical effects, provide experimental evidence for inhibition at a pre-lexical level.

Future Directions

- Investigate further the speed/accuracy trade-off found in Experiment 2.
- Run a full, controlled study using onset overlap – preliminary accuracy data from Experiment 1 look promising.

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