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Linguistic Phonetics

Phonology and Lexical Access

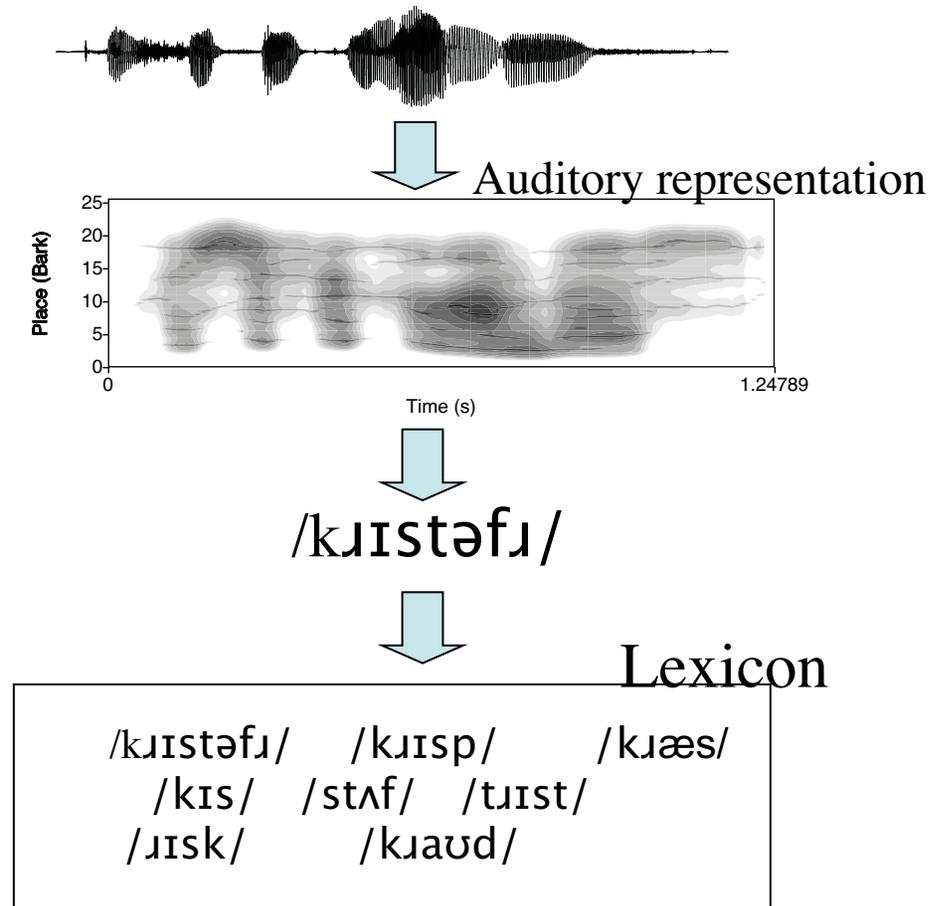


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- Reading: Ohala, John J. (1981) 'The listener as a source of sound change'

Speech Perception and Lexical Access

- The problem faced by the listener:
To extract meaning from the acoustic signal.
- This task involves the recognition of words - lexical access.
- Traditional division:
 - Speech perception covers the mapping from acoustic signal to intermediate representation.
 - Lexical access involves identifying words based on intermediate representations.
- Much controversy surrounds the nature of intermediate representations.



The role of phonetic and phonological grammar in speech perception/lexical access

- Speech signals are highly structured - generated by grammars (phonological/phonetic).
- It would make sense for listeners to make use of their knowledge of grammar to drive their interpretation of speech signals.
- The recognition problem: Given a speech signal, what sequence of words is most likely to have given rise to that signal?
 - Phonetics and phonology govern the phonetic realization of words, so an optimal solution to the recognition problem will exploit knowledge of these components of grammar.
 - Note that listeners need to know about other speakers' grammars, not just their own.

A role for phonetic/phonological grammar in speech perception: parsing contextual effects

- Gaskell and Marslen-Wilson (1996) suggest that listeners use knowledge of assimilation processes to ‘undo’ assimilation in the process of lexical access.
- E.g. English: coronals can assimilate substantially to place of articulation of a following consonant.
 - $n \rightarrow m / _ [\text{labial}]$
 - $[\text{limbeɪkŋ}] \rightarrow \text{linbeɪkŋ}/\text{limbeɪkŋ} \rightarrow$ ‘lean bacon’
 - $[\text{leɪkkɔl}] \rightarrow \text{leɪtkɔl}/\text{leɪkkɔl} \rightarrow$ ‘late call/lake call’

A role for phonetic/phonological grammar in speech perception: parsing contextual effects

- Alternative accounts of lexical access in the face of significant (near-neutralizing) variation in word form:
 - Phonological parsing
 - Permissive matching between stimulus and lexicon.
 - Multiple pronunciation variants listed in the lexicon.
 - Underspecified lexical representations (Lahiri and Marslen-Wilson).
 - Feature parsing (Gow)

Permissive matching in lexical access

- [lim] is close enough to [lin] to activate ‘lean’, resulting in access since this is the best match in the lexicon.
- [leɪk(kɔl)] is close enough to [leɪt] to activate ‘late’, ultimately resulting in access since this makes more sense than competitor ‘lake’.
- listed pronunciation variants: [lim] is listed as a possible pronunciation for ‘lean’.
- Prediction: [lim] always activates ‘lean’
- Phonological parsing: coronal assimilation only derives /lin/ → [lim] before labials.
- There is evidence for this context-specificity.

Gaskell & Marslen Wilson (1996)

- Priming study of coronal assimilation:
 - Play utterance containing prime word.
 - Present printed word for lexical decision.
 - Repetition priming: lexical decision to visual word is faster when the word has just been heard.
- Primes:
 - Unmodified word: [wɪkɪd]
 - Assimilated word: [wɪkɪb pɹæŋk]
 - Non-assimilatory modification: [wɪkɪb geɪm]
 - Control: unrelated word.
- Assimilated words produce a stronger priming effect than non-assimilated modified words.
- [wɪkɪb pɹæŋk] primes ‘wicked’ more than [wɪkɪb geɪm].
- If [wɪkɪb] activates ‘wicked’ because it is ‘close enough’, then this effect should be similar in both contexts.

Underspecified lexical representations

- Lahiri and Marslen-Wilson (1991, 1992) proposed that lexical representations lack feature specifications in certain contexts.
- In English [coronal] is not specified.
- Any place specification in the input will be consistent with the lexical representation of a coronal - [leɪp], [leɪt], [leɪk] activate 'late' equally.
- This is similar to permissive matching (matching is strict, but some lexical representations are 'permissive'), so is not sufficient to account for cases in which activation by a non-canonical form is stronger in assimilatory contexts.
- NB Lahiri et al (2002) did find that in German *Bah*[m] primes visual *Zug* 'train' as much as canonical *Bahn* 'railway'

Feature parsing

- Gow (2001, 2002) shows that English coronal assimilation is not complete - the result retains some cues to the presence of an alveolar (and some articulatory remnants of the alveolar - Nolan 1992).

Feature parsing:

- [liⁿm...] contains cues to both [coronal] and [labial].
- On hearing following [b], [labial] is attributed to [b], and [coronal] is assigned to the nasal, resulting in [lin].
- If there is no following labial (liⁿmgeɪm), [labial] and [coronal] cannot both be accommodated - if evidence for [labial] is stronger, perceive [lim].
- Feature parsing is argued to be a general perceptual mechanism - not based on knowledge of coronal assimilation.
- Not applicable to total assimilation as in Gaskell and Marslen-Wilson's stimuli.
- Not applicable to non-assimilatory phenomena (e.g. deletion/extreme reduction).

Post-lexical vs. Pre-lexical processes

- Do not confuse with lexical and post-lexical phonology!
 - A pre-lexical process is one that occurs before matching to lexical representations.
 - A post-lexical process is one that occurs after lexical access (or at least after candidates for lexical access have been identified).
- Gaskell and Marslen-Wilson propose that listeners use knowledge of phonological processes pre-lexically - i.e. parsing the input to derive representations for lexical matching.
- Could phonological rules be applied to choose between word candidates after lexical access?
 - [wikibgeɪm] initially activates ‘wicked’ , but suppressed when following context is phonologically inappropriate.

Processing contextual variation

- Multiple mechanisms could be at work in processing substantial contextual modifications (like assimilation).
- E.g. [lim] activates [lin] to some extent in non-assimilatory contexts, but less than in assimilatory context.
- G&M-W (1998) found that listeners ‘recovered’ [t] by undoing assimilation in non-words in a phoneme-monitoring task
 - suggests pre-lexical parsing
- but they recovered /t/ more often in real words, suggesting there is also a lexically-based mechanism involved.

Mitterer, Csépe & Blomert (2006)

- Used cross-language comparison to test whether compensation for assimilation depends on knowledge of the assimilation process, or is based on general perceptual mechanisms (cf. feature parsing).
- Test for pre-lexical compensation using non-words.
- Hungarian liquid assimilation: /l/ → [r] / _ r
 - bɔlro:l / bɔrro:l ‘from the left’
 - bɔlna:l / *bɔrna:l ‘at the left’
- Subjects: Hungarian and Dutch speakers.
 - Dutch listeners have no experience of liquid assimilation.
 - If Dutch listeners can compensate for assimilation, they must be using general mechanisms.

Mitterer, Csépe & Blomert (2006)

- Hungarian liquid assimilation: /l/ → [r] / _ r
bəlro:l / bərro:l ‘from the left’
bəlna:l / *bərna:l ‘at the left’
- Constructed bəl-bər (word-nonword) and zəl-zər (both non-words) continua through resynthesis.
- Spliced onto ro:l or na:l
- Task: identification as bəl-bər / zəl-zər (orthographic labels bal-bar /zal-zar).
- Subjects: Hungarian and Dutch speakers.

Results

- Undoing assimilation should yield more [l] responses.
- More compensation in viable contexts for words and non-words - pre-lexical effect.
- But non-word does pattern differently from word continuum before 'nal'

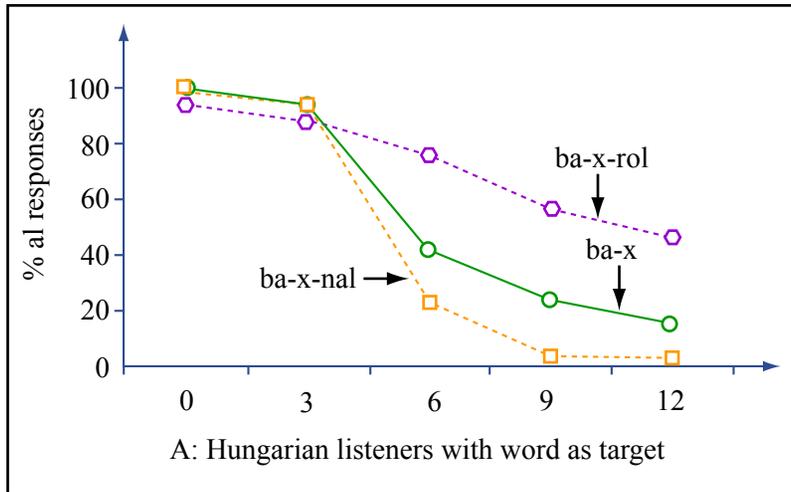


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Adapted from Mitterer, H., V. Csepe, and L. Blomert. "The role of perceptual integration in the perception of assimilation word forms." *Quarterly Journal of Experimental Psychology* 59 (2006): 1395-1424.

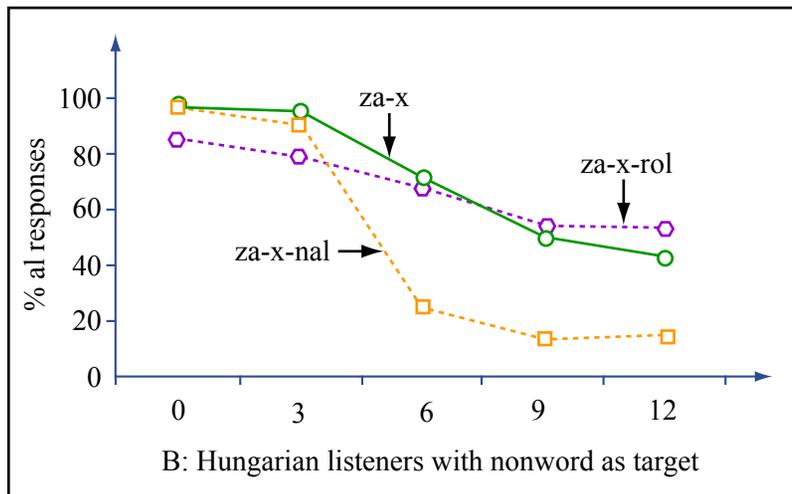


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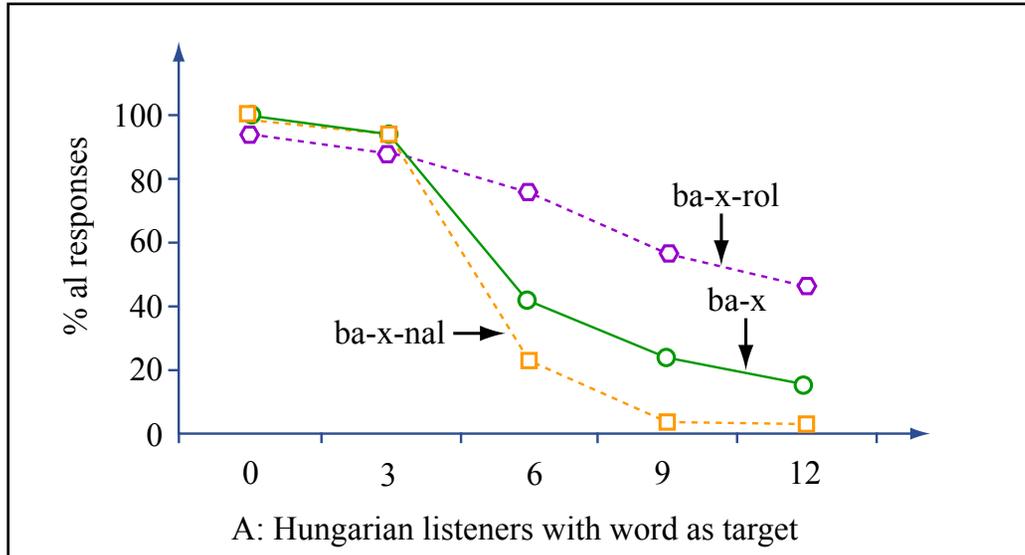


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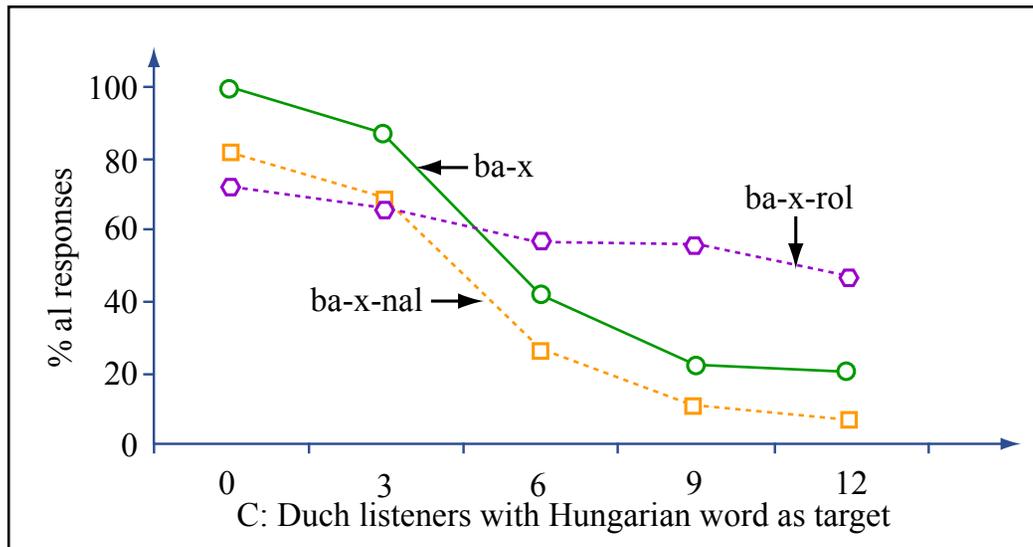


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Results

- Dutch listeners perform differently from Hungarian listeners.
- Mitterer et al conclude that Dutch listeners show partial compensation for assimilation.
- It looks more like simple confusion in the 'rol' context.
 - Use shift in category boundary as a measure of compensation?
- Confound: neutralization tends to arise in contexts where contrast would be poorly cued.

Cross-language studies of compensation for assimilation

- This cross-language methodology has been employed in a number of studies looking for evidence that knowledge of an assimilation process is required to ‘undo’ that process in lexical access.
 - E.g. Darcy et al (2009), Gow & Im (2005).
- Mixed results - Gow & Im found no difference between native and non-native listeners in segment monitoring tasks involving Hungarian voicing assimilation and Korean place assimilation.

/t/ deletion in Dutch

- Deletion processes provide a good test of the proposed mechanisms for processing contextual variation.
 - e.g. tɛst, tɛs ‘test’
- It is not clear that feature parsing can generalize to deletion/extreme reduction.
- Underspecification of features in the lexicon cannot account for ‘recovery’ of deleted segments.
- Mitterer & McQueen (2009) examine lexical access in the face of /t/ deletion in Dutch.

/t/ deletion in Dutch

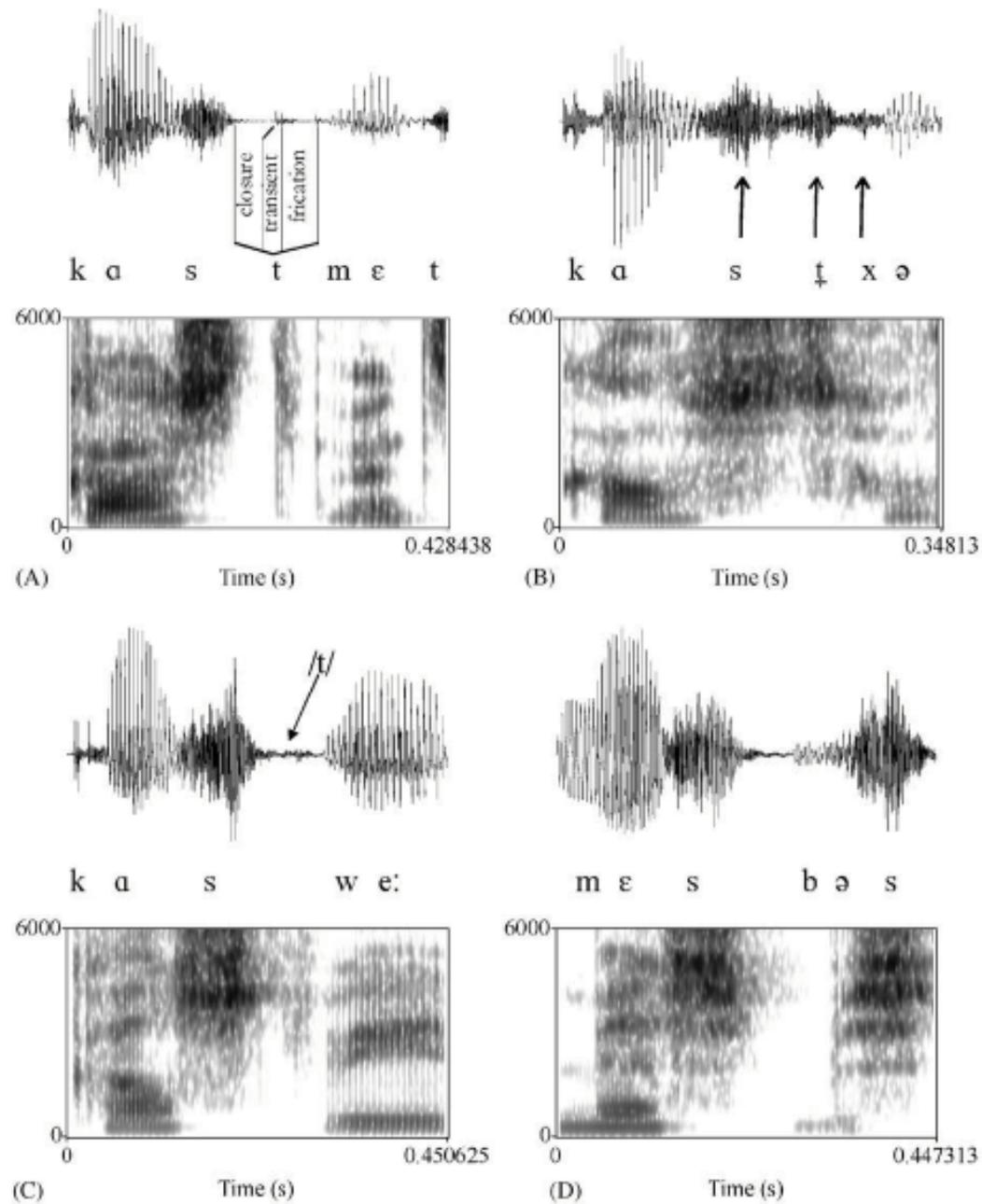
- Dutch word-final /t/ can be lenited or even apparently deleted (Mitterer & Ernestus 2006, based on Corpus of Spoken Dutch):
 - Usually post-consonantly
 - More after [s] than after [n, x] (e.g. kast̥ > kant̥)
 - More before obstruents than vowels.
 - More before labials than before alveolars.

The proportion of /t/ deletion as a function of previous and following context (number of observations in brackets) in Corpus Study 2 (C stands for consonant)

Following context	Preceding context			Mean
	/s/	Consonant	Vowel	
Vowel	0.77 (13)	0.18 (22)	0.00 (8)	0.32 (43)
Bilabial C	0.67 (3)	0.90 (10)	1.00 (2)	0.87 (15)
Back C	0.75 (8)	0.14 (14)	0.00 (2)	0.33 (24)
Alveolar C	1.00 (9)	0.00 (4)	0.00 (1)	0.50 (18)
Labiodental C	0.75 (16)	0.00 (12)	0.00 (3)	0.39 (31)
Mean	0.80 (50)	0.33 (65)	0.12 (16)	0.46 (125)

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Source: Mitterer, Holger, and Mirjam Ernestus. "Listeners recover /t/s that speakers reduce: Evidence from /t/-lenition in Dutch." *Journal of Phonetics* 34, no. 1 (2006): 73-103.

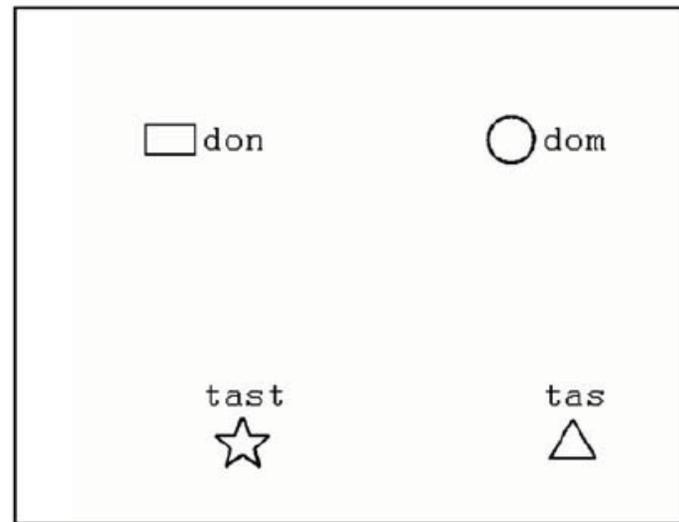


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/t/ deletion in Dutch

Eye tracking paradigm.

- Four words presented above/next to geometrical shapes.
- Target words: minimal pair differing in presence/absence of final [t], e.g. *tast-tas*
- Spoken instructions to click on one of the words
 - klik op het woordje (target) bovə də / nast də stER/sIRkEl...
 - click on the word (target) above/next to the star/circle...
 - in production, t-deletion is more likely before [b] than [n].



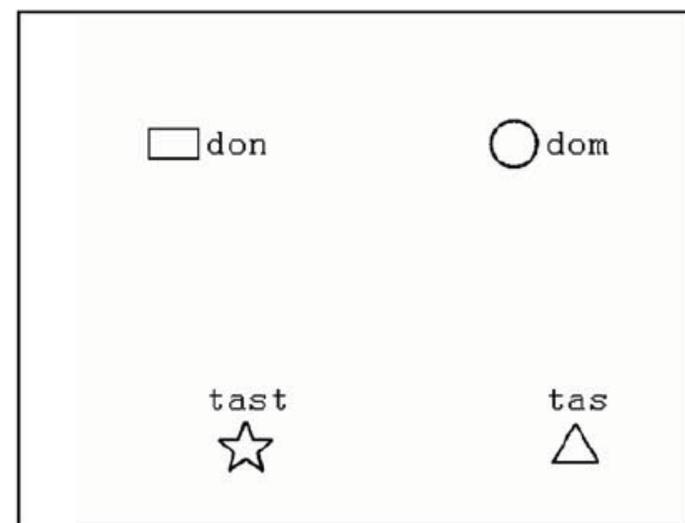
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Source: Mitterer, Holger, and James M. McQueen. "Processing reduced word-forms in speech perception using probabilistic knowledge about speech production." *Journal of Experimental Psychology: Human Perception and Performance* 35, no. 1 (2009): 244.

/t/ deletion in Dutch

- Track eye movements as subjects perform the task.
- Listeners look at the word they think they are hearing, so we can use eye fixations over time to observe the time course of lexical access.

klik ɔp ət wordjə tas(t) bovə də stɛR

- target is temporarily ambiguous. When do listeners start to disambiguate?



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/t/ deletion in Dutch

Stimuli

- XCt words with XC minimal pairs, recorded by one speaker
 - kast-kas, kaft-kaf, schort-schor, etc
- Two versions of each:
 - +/t/ bias: visible closure, no release burst (deleted if necessary)
 - -/t/ bias: shorten closure by 25ms, lengthen preceding consonant by 25 ms (C in /-Ct#/ is shorter than in /-C#/).

Measures:

- Reaction time to click
- Distance of eye fixation to each stimulus, over time (250 Hz sampling rate).

Results

- Analysis of controls indicated a ‘window of ambiguity’ in time bins 72-91.
- /t/ bias and following context (n- vs. b-) both affected distance to Ct# vs. C# words in this interval.
- Mean distance to Ct# is smaller if following context is labial
- Mean distance to Ct# is smaller if stimulus is +/t/ bias.
- Overall Ct# bias
- Listeners are more likely to identify stimuli as Ct# words in the context where /t/ deletion is more likely.

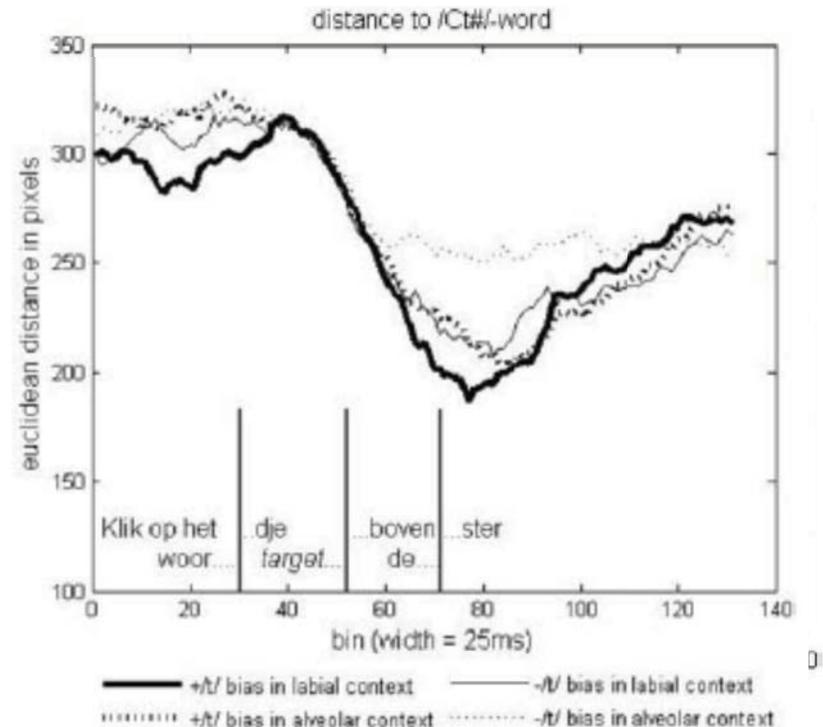


Figure 8. Experiment 1: Distance between fixation position and the different types of stimuli in the stop trials based on their phonological properties. The thick lines indicate the distances for stimuli in which the acoustic form induced a +/t/ bias, the thin lines those in which the form induced a -/t/ bias. The continuous lines show the distances in the labial-context condition (“boven”) and the dotted lines show the distances in the alveolar-context condition (“naast”).

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 Source: Mitterer, Holger, and James M. McQueen. "Processing reduced word-forms in speech perception using probabilistic knowledge about speech production." *Journal of Experimental Psychology: Human Perception and Performance* 35, no. 1 (2009): 244.

Summary

- Processing of contextual variability seems to be based on knowledge of the grammatical processes that produce the variability.
- Permissive matching and underspecified lexicon (Lahiri) cannot account for the fact that listeners are only likely to ‘undo’ processes in the contexts where they apply in production.
- Feature parsing (Gow) cannot account for cases in which language-specific knowledge is required to ‘undo’ processes.
- Neither mechanism can account for recovery of deleted segments.

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