Competition and real speech

- Word recognition is rapid even though speech signals are full of spurious words (e.g. *spoken word* has two intended words and 12 spurious – *spoke, oak, whirr, err* etc.)
- Recognition is achieved by multiple activation of candidate words, and inter-word competition
- In an ideal world, the phonetic forms encountered in speech would exactly match the phonetic expectations based on representations stored in the lexicon
- But this workshop is not about the ideal world….
- One far-from-ideal situation: Listening to speech in a second language

L2 phonetic confusions and competition

1. Pseudo-homophony evidence: Pseudo-homophones cause repetition priming (e.g. *write* is recognized faster after *light* by Japanese listeners, *kettle* is recognized faster after *cattle* by Dutch listeners; Cutler & Otake, 2004).

2. Extended ambiguity evidence: Dutch listeners hearing *click on the pan-* look at both a panda and a pencil; Japanese listeners hearing *click on the rock-* look at a locker and a rocket (Weber & Cutler, 2004; Cutler Weber & Otake, 2006).

3. Spurious activation evidence: Dutch listeners recognise *deaf* if they hear *daff-* from *daffodil* (Broersma, 2005).

L2 phonetic confusions and competition

- In L2, phonetic identification is often imprecise
- Particularly, problems arise when categories of the L2 are collapsed in the L1 phoneme category system (e.g. English r/l for Japanese listeners etc.)
- Such phonetic confusions can exacerbate the competition in speech recognition in at least three ways:
    1. Pseudo-homophony: Minimal pairs such as *write*, *light* sound the same (as true homophones, e.g. *meet, meat*)
    2. Extended ambiguity: e.g. Distinguishing *legislate* from *register* at the 6th instead of the 1st phoneme
    3. Spurious activation: Activation of embedded words which aren't there, e.g. *leg* in *regular*

Lexical statistics of L2 phonetic confusions

Method: statistics from the CELEX corpus for British English (70,000+ words; frequency statistics based on 17.9 million word corpus)

- One vowel and one consonant confusion. N.B. consonant misperceptions (*light > write, might, kite* etc.) activate more other words than vowel misperceptions (*light > let, loot*, etc.)
- Vowel: æ-ɛ (difficult for Dutch or German listeners); Consonant: r-l (difficult for Japanese or Chinese listeners)
- For pseudo-homophony: How often does a given phoneme confusion produce another existing word (e.g. *write/light*)
- For extended ambiguity: How many more possible words stay active if phonemes are confused (*regis-/legis-*)
- For spurious activation: How many spuriously embedded words result from a phoneme confusion (e.g. *leg* in *regular*)

Lexical statistics: Pseudo-homophones

Number of added homophones in lexicon per confusion:

æ-ε	ε-æ	r-l	l-r
137	135	311	287
cattle	*kettle*	*write*	*light*

(Not mirror image because of words like *access*, *lorry*…)

* Number of actual (orthographically distinct) homophones in English lexicon (*meat, meet, bury, berry* etc.): 660
* Number of effective homophones in normal speech: cannot be estimated, but potentially vast
* Addition of a few hundred pseudo-homophones is trivial
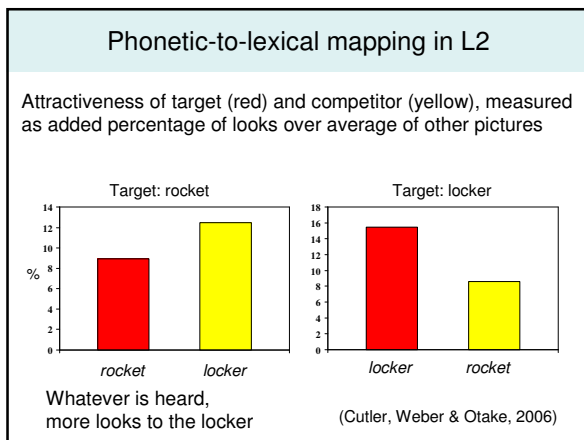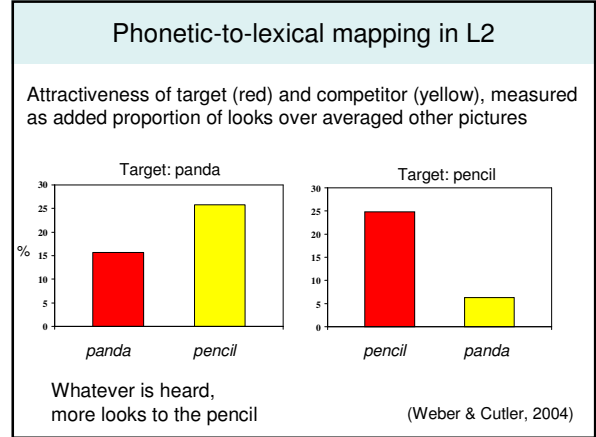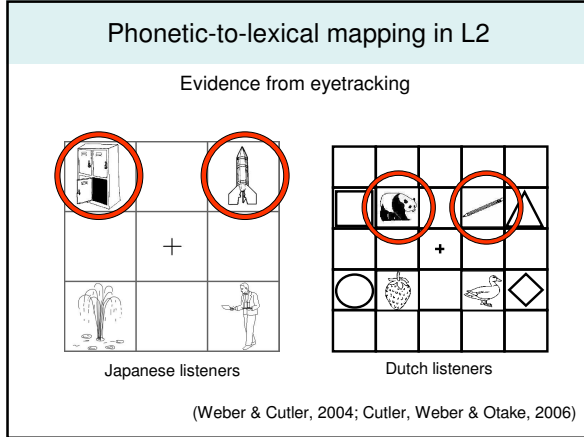
Lexical statistics: Spurious activation

[æ] *cat* in *catch, cattle, ketch, kettle…*
[ε] *neck* in *next, nectar, snack, almanac…*
[l] *leave* in *sleeve, relieve, grieve, bereave…*
[r] *rib* in *crib, ribbon, glib, liberty…*

Lexical statistics: Extended ambiguity

[æ] actor, sandy, elastic, veranda, compact…

[ε] every, better, pleasant, cadet, confess…

[l] lady, please, follow, spelling, insolent….

[r] radio, great, parade, cleric, interrogate…

Lexical statistics: Conclusion

• Pseudo-homophony is not the worst problem. Listeners have to deal with homophones all the time. A few hundred extra homophones will be a nuisance, but manageable.

• Extended ambiguity and spurious activation, however, could pose very serious problems for L2 listeners. The extra competition they cause could really slow word recognition.

• But the story is further complicated by the fact that L2 users' lexical representations are not a direct reflection of what is perceived in speech....

Phonetic-to-lexical mapping in L2

Evidence from eyetracking

Japanese listeners   Dutch listeners

(Weber & Cutler, 2004; Cutler, Weber & Otake, 2006)

Phonetic-to-lexical mapping in L2

Attractiveness of target (red) and competitor (yellow), measured as added proportion of looks over averaged other pictures

Target: panda

Target: pencil

panda   pencil   pencil   panda

Whatever is heard,
more looks to the pencil

(Weber & Cutler, 2004)

Phonetic-to-lexical mapping in L2

Attractiveness of target (red) and competitor (yellow), measured as added percentage of looks over average of other pictures

Target: rocket

Target: locker

rocket   locker   locker   rocket

Whatever is heard,
more looks to the locker

(Cutler, Weber & Otake, 2006)

Phonetic-to-lexical mapping in L2

- Japanese tend to hear English /ɾ/ or /l/ as /l/;
  Dutch hear English /æ/ and /ɛ/ as /ɛ/
- But the representations most likely to be contacted in the lexicon are those which <u>properly</u> contain /l/ and /ɛ/
- So the lexical representations of *locker*, *rocket* or *panda*, *pencil* have different first syllables, even though this difference is not heard in the input
- The lexical difference must come from information beyond listening experience (e.g. orthography)
- Experience with orthography can induce an immediate lexical distinction for novel words, which without spelling are heard as homophonous

Phonetic-to-lexical mapping in L2

Dutch listeners trained on novel "English" names

1. audio only:

2. spelling and audio:

Audio only – they are effectively homophones. But orthographic information induces lexical representation of a phonological distinction

Target: tandik

Target: tenzer

tandik *tenzer*

tenzer *tandik*

tandik *tenzer*

tenzer *tandik*

Eyetracking data: added proportion of looks

(Escudero, Hayes-Harb & Mitterer, 2008)

Spurious activation in L2: Truncated primes

Cross-modal priming in English; Target e.g. *deaf* given prime *def-* (from *definite*) versus *daf-* (from *daffodil*). Priming expressed as % difference from control.

English (L1 listeners): priming by *def-* but not by *daf-*.

Dutch (L2 listeners): significant priming by both.

def-
daf-

% difference from control

English L1   Dutch L2

(Broersma & Cutler, submitted)

Spurious activation in L2

Dutch listeners to English hear "words" where native listeners do not: in lexical decision, *daff*, *chass*, *lem, stemp*, etc, receive YES responses.

Is this a real problem for L2 listening?
Do native speakers say non-words to L2 listeners?

Yes, by accident. Such strings appear, embedded in real words or phrases:

daff in *daffodil*,
chass in *chastise*,
lem in *lemon*,
stemp in *The Last Emperor*…

(Broersma & Cutler, submitted)

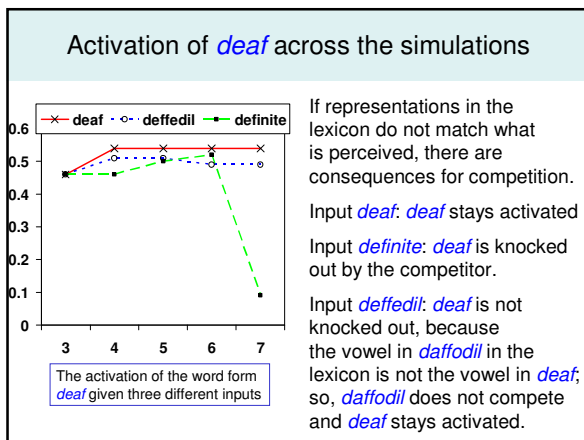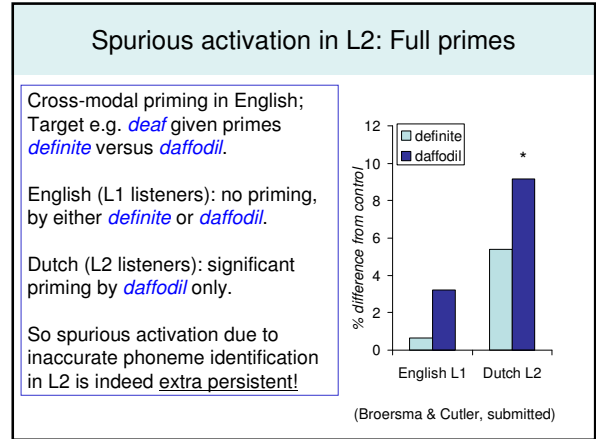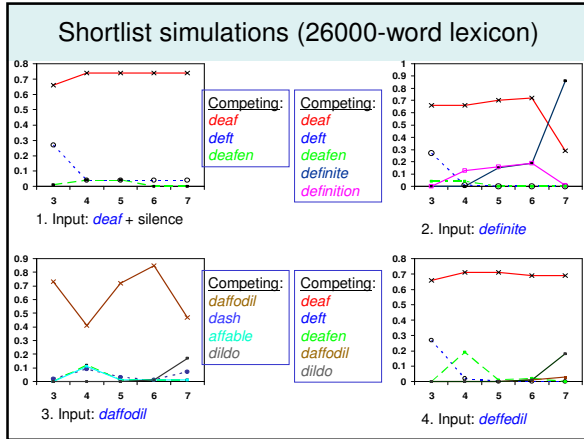## Spurious activation in L2: Cross-word primes

Cross-modal priming in English; Target e.g. *lamp* given prime *-lamp-* (from *evil amplitude*) versus *-lemp-* (from *evil empire*).

English (L1 listeners): priming by *-lamp-* but not by *-lemp-*.

Dutch (L2 listeners): significant priming by both.

-lamp-
-lemp-

% difference from control

English L1   Dutch L2

(Broersma & Cutler, submitted)

Shortlist simulations (26000-word lexicon)

Competing:	Competing:
deaf	*deaf*
deft	*deft*
deafen	*deafen*
	definite
	definition

1. Input: *deaf* + silence

2. Input: *definite*

Competing:	Competing:
daffodil	*deaf*
dash	*deft*
affable	*deafen*
dildo	*daffodil*
	dildo

3. Input: *daffodil*

4. Input: *deffedil*

Spurious activation in L2: Full primes

Cross-modal priming in English;
Target e.g. *deaf* given primes
definite versus *daffodil*.

English (L1 listeners): no priming,
by either *definite* or *daffodil*.

Dutch (L2 listeners): significant
priming by *daffodil* only.

So spurious activation due to
inaccurate phoneme identification
in L2 is indeed __extra persistent__!

(Broersma & Cutler, submitted)

Activation of *deaf* across the simulations

The activation of the word form
deaf given three different inputs

If representations in the
lexicon do not match what
is perceived, there are
consequences for competition.

Input *deaf*: *deaf* stays activated

Input *definite*: *deaf* is knocked
out by the competitor.

Input *deffedil*: *deaf* is not
knocked out, because
the vowel in *daffodil* in the
lexicon is not the vowel in *deaf*;
so, *daffodil* does not compete
and *deaf* stays activated.

Competition dynamics in L2

- The real world of L2 listeners is particularly prone
  to lexical competition.
- On the one hand, phonemes of the L2 are likely
  to be misperceived.
- The structure of vocabularies ensures that whenever
  such phoneme misperceptions occur, spurious activation
  of pseudo-embedded words is very likely.
- But on the other hand, misperceptions can co-exist with
  accurate lexical representations, and this forms a fatal
  combination!
- It leads to extra-persistent competition (i.e., competitors
  which are not knocked out of the competition by their
  carrier words as they should be).