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Online processing of German (mor)phonotactic clusters by adults and adolescents

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C clusters and their distributional restrictions

- Clusters allowed in monomorphemic units ('phonotactic clusters', with exclusive phonological motivation) vs. clusters resulting from morphological concatenation ('morphonotactic clusters')

- 'Morphonotactic' clusters sometimes violate morpheme-internal phonological restrictions

  English /-fs, -vz/ as in *laughs*, *loves*, *wife's…*

  German /-xst/ as in *lach+st* 'you laugh'

- In other cases, morphological concatenation produces morphonotactic clusters that do not violate phonotactic rules:

  German /-l(#)st/ as in *sattel+st* 'you staddle' vs. monomorphemic *Wulst* 'bulge'

(Dressler & Dziubalska-Kołaczyk 2006)

Processing morphonotactic clusters

Strong Morphonotactic Hypothesis

Morphonotactic clusters - and especially those that are exclusively or strong default morphonotactic - function as boundary signals, facilitate the processing of morphologically complex words, and are easier to acquire

- Morphonotactic clusters are acquired earlier and faster by typically developing children (but are more difficult for children with SLI)
  (Marshall & van der Lely 2006, Kamandulyte 2006, Zydorowicz 2007, Fürst et al. 2011)
- Adults detect consonants, C clusters and VC sequences faster if they are adjacent to a morpheme boundary (= if they form morphonotactic clusters
  (Freiberger et al. 2011, Korecky-Kröll et al., submitted)

Processing morphonotactic clusters

Non-exclusively morphonotactic clusters (e.g. German /-l(#)st/)

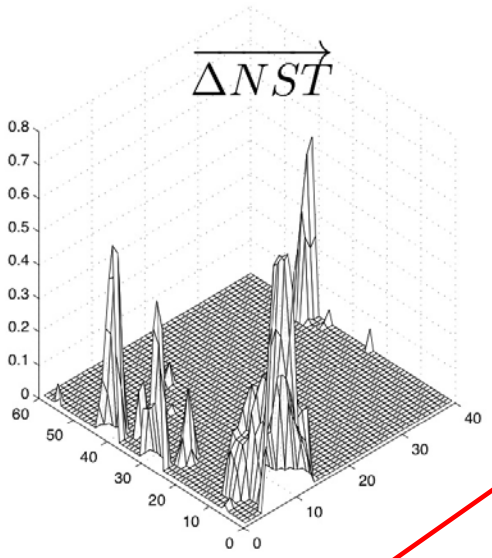
- Are they differently processed with respect to their homophonous phonotactic counterparts?
- Are there two different phonotactic ‘representations’ for homophonous C#CC vs. CCC clusters?
- Are there acquisitional preferences?
- Do speech production strategies change for C#CC vs. CCC?

Processing morphonotactic clusters

Non-exclusively morphonotactic clusters (e.g. German /-l(#)st/)

- Are they differently processed with respect to their phonotactic homophonous counterparts?
- **Are there two different phonotactic 'representations' for homophonous C#CC vs. CCC clusters? → computational study**
- Are there acquisitional preferences?
- Do speech production strategies change for C#CC vs. CCC?

A computational approach to morphonotactics: evidences from German B. Calderone, C. Celata, K. Korecky-Kröll, W.U. Dressler (submitted to *Language Sciences*)



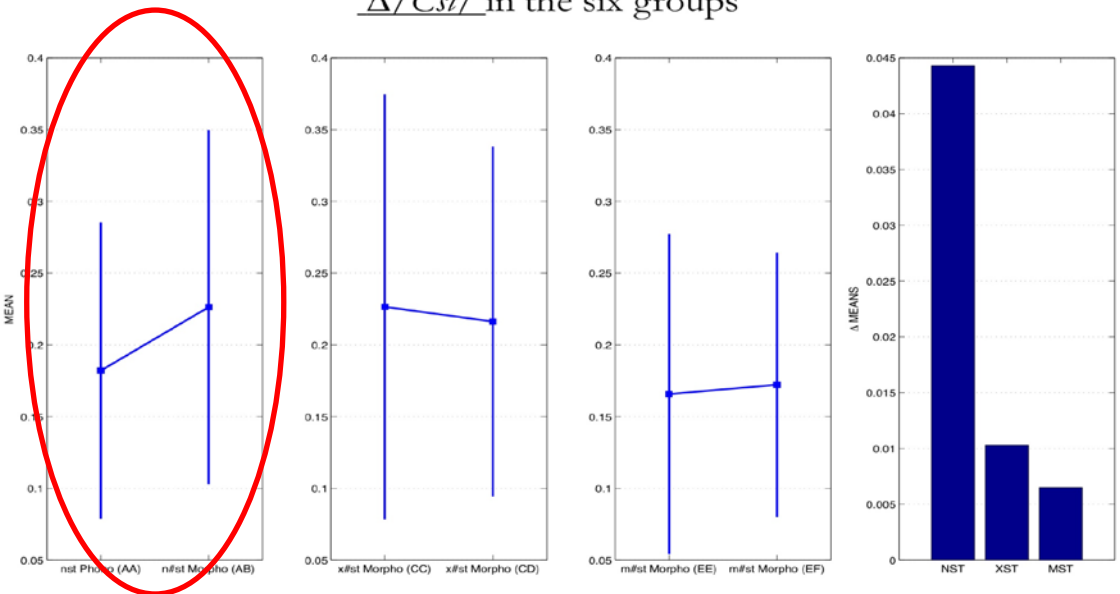
Sequence /nst/		Sequence /xst/		Sequence /mst/	
A	B	C	D	E	F
Kunst	kannst	sprichst	tunlichst	kommst	leimst
Wanst	nennst	suchst	fluchst	nimmst	kamst
Gespenst	verzinst	rauchst	kochst	bremst	bimst
...	...	...	...	...	...

90 words in total

Null hypothesis: no significative difference between the groups

$(A, B) = (C, D) = (E, F)$

$\Delta/Cst/$ in the six groups



Morphological boundaries may have an impact on phonotactic representations

Processing morphonotactic clusters

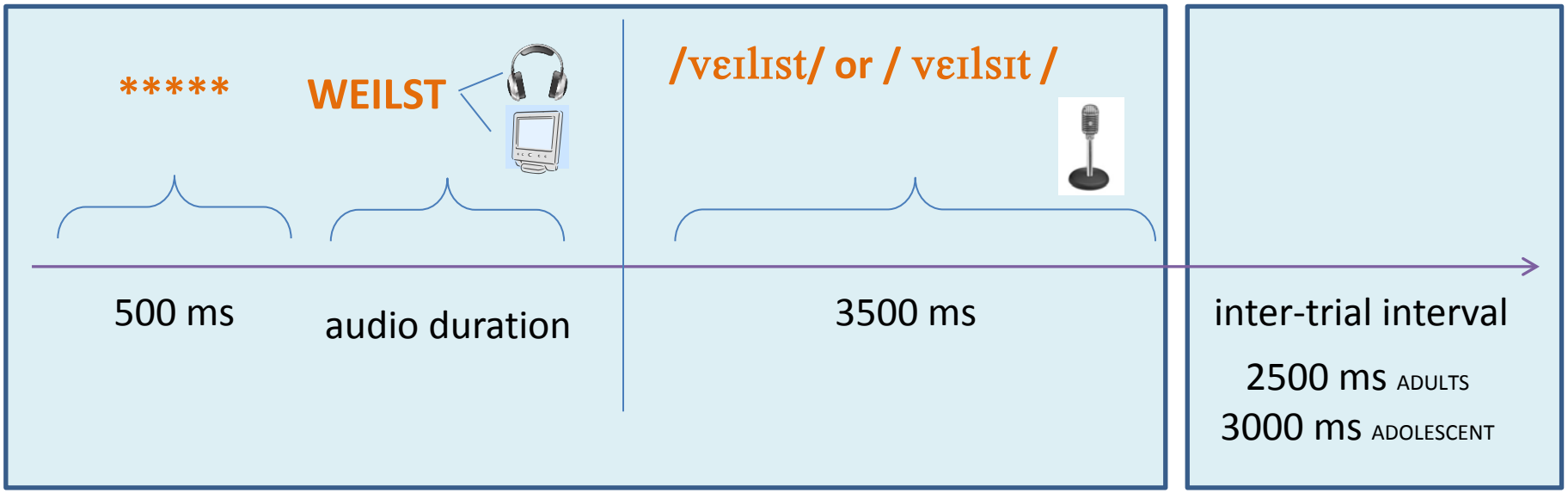
Non-exclusively morphonotactic clusters (e.g. German /-l(#)st/)

- **Are they differently processed with respect to their phonotactic homophonous counterparts? → 2 behavioral experiments on Austrian German**
- Are there two different phonotactic 'representations' for homophonous C#CC vs. CCC clusters? → computational study
- Are there acquisitional preferences?
- Do speech production strategies change for C#CC vs. CCC?

EXPERIMENT #1 'Split cluster' test

"Insert /i/ as fast as possible whenever you find a C cluster in the word stimulus"

Training: participants instructed to split CC clusters (LUFT > "lufit", BRAUCH > "birauch"
Test: split CCC clusters (intermixed with many CC fillers)



Microphone and Headphones

Experimental items

	Phonotactic			**Morphonotactic**		
Cluster type		Frequency			Frequency	
/nst/	**DUNST**	386		**KENNST**	102	
	WANST	5		**KANNST**	1661	
	KUNST	6325		**MEINST**	102	
	GUNST	1388		**NENNST**	21	
/pst/	**OBST**	869		**LOBST**	94	
/lst/	**WULST**	20		**WEILST**	45	
/Nst/	**ANGST**	17370		**LÄNGST**	19756	
Average frequency		*3766.143*			*3111.571*	

Frequencies calculated as occurrences in *Leipzig Deutscher Wortschatz Online* (500 million words)

A general preference for the “IST” splitting strategy (over the “SIT” one) must be expected:

- /-ist/ more frequent than /-sit/ word finally in German
- /CVst/ phonotactically preferred with respect to /nsV/ or /psV/

Nevertheless, for MORPHO clusters there is a further effect:
“IST” strategy *consistent with the concatenation process* (e.g. *lob+i+st*)

Prediction:
MORPHO clusters are more easily, quickly and frequently split according to the IST response type, compared to PHONO clusters.

Analysis:

- type of response: CiCC vs. CCiC vs. null response
- RTs

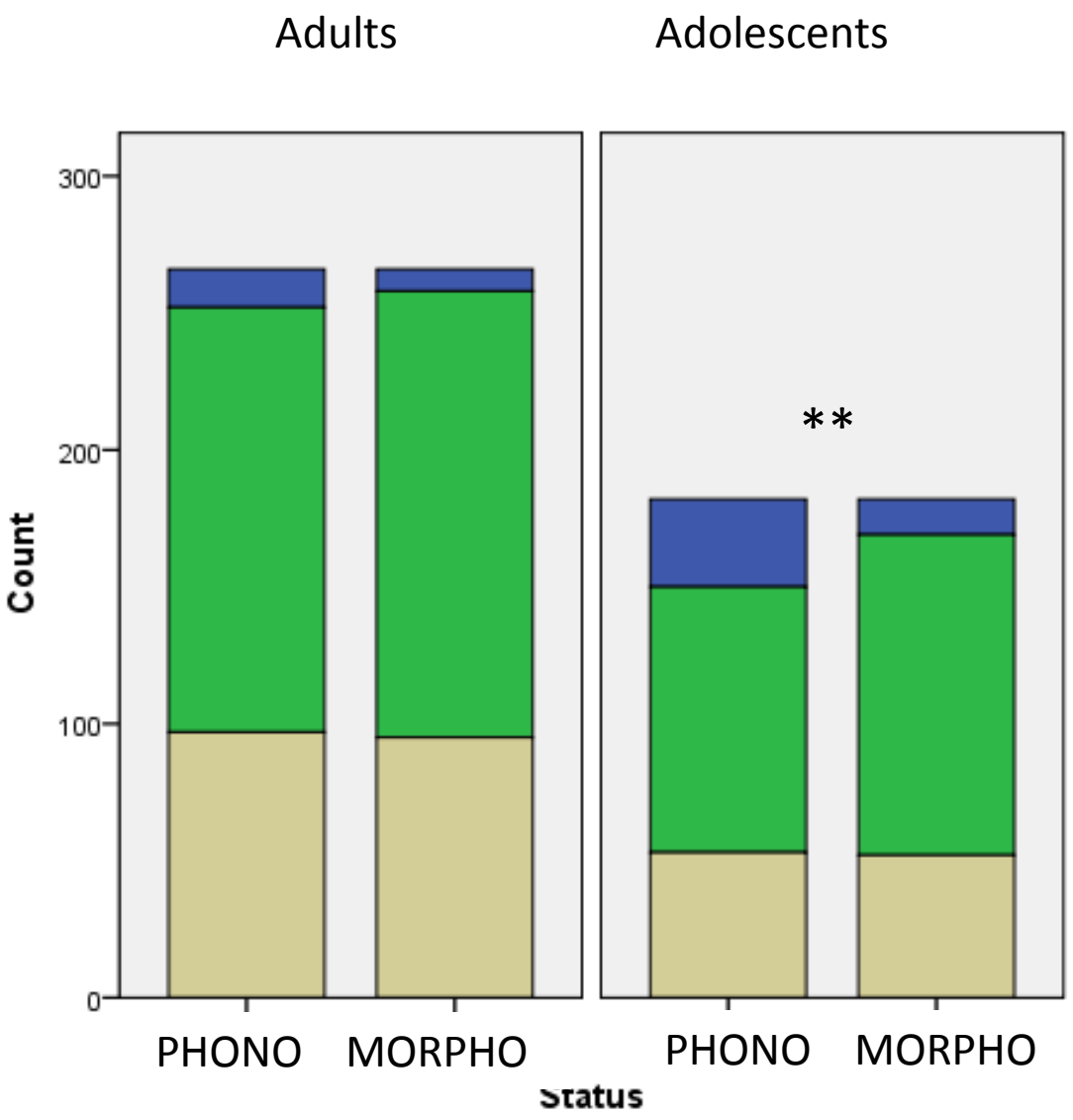
2 groups of native Austrian German speakers:
38 adults
26 adolescents (<16 y.o.)

Exp 1-Results: response type

Overall, the subjects made more errors at splitting PHONO clusters than MORPHO clusters

Response

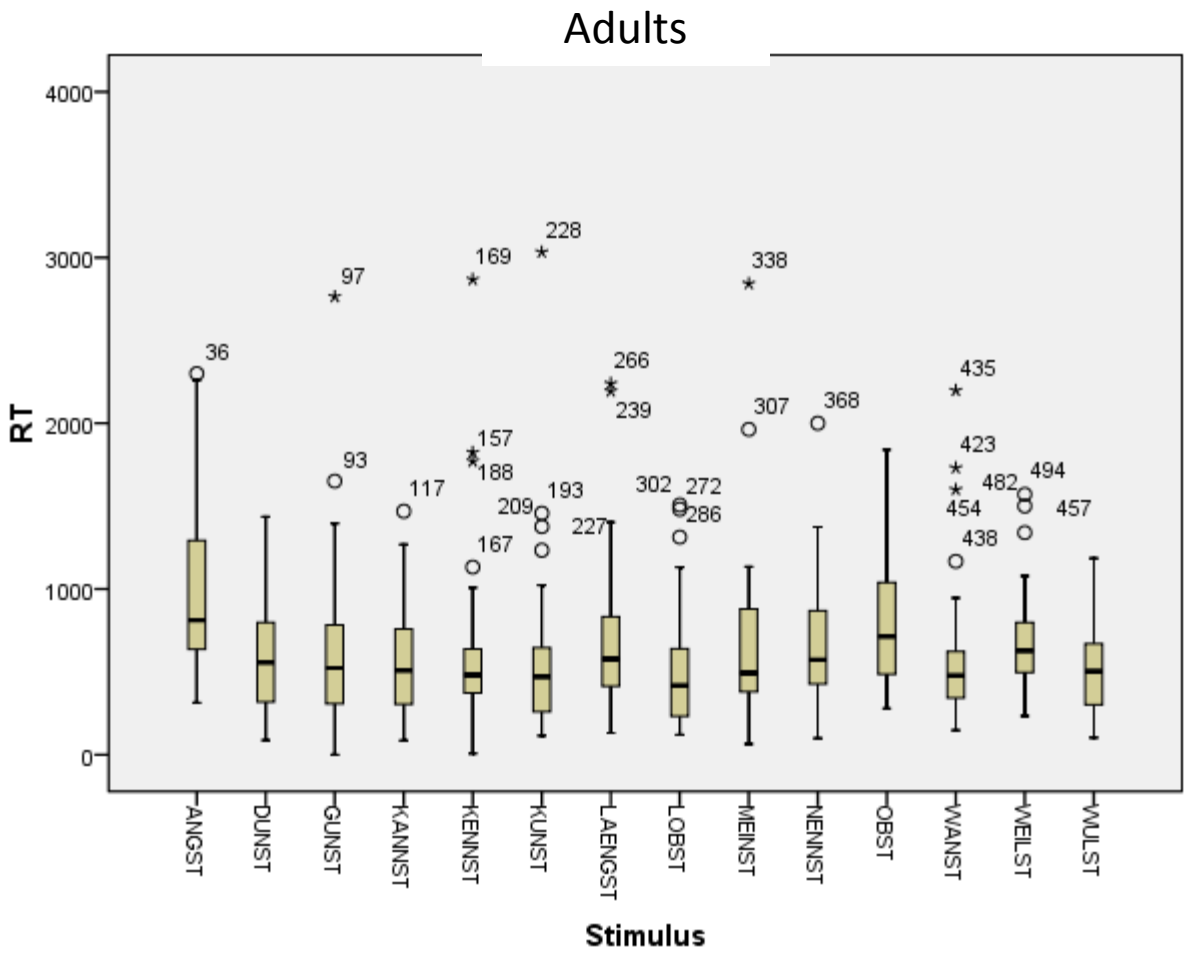
ager ange	Status			Frequency	Percent	Valid Percent	Cumulative Percent
adult	phono	Valid	0	14	5,3	5,3	5,3
			ist	155	58,3	58,3	63,5
			sit	97	36,5	36,5	100,0
			Total	266	100,0	100,0	
	morpho	Valid	0	8	3,0	3,0	3,0
			ist	163	61,3	61,3	64,3
			sit	95	35,7	35,7	100,0
			Total	266	100,0	100,0	
adolescent	phono	Valid	0	32	17,6	17,6	17,6
			ist	97	53,3	53,3	70,9
			sit	53	29,1	29,1	100,0
			Total	182	100,0	100,0	
	morpho	Valid	0	13	7,1	7,1	7,1
			ist	117	64,3	64,3	71,4
			sit	52	28,6	28,6	100,0
			Total	182	100,0	100,0	



MORPHO clusters are both **easier** to split, and more frequently split according to the **IST option**, if compared to PHONO clusters

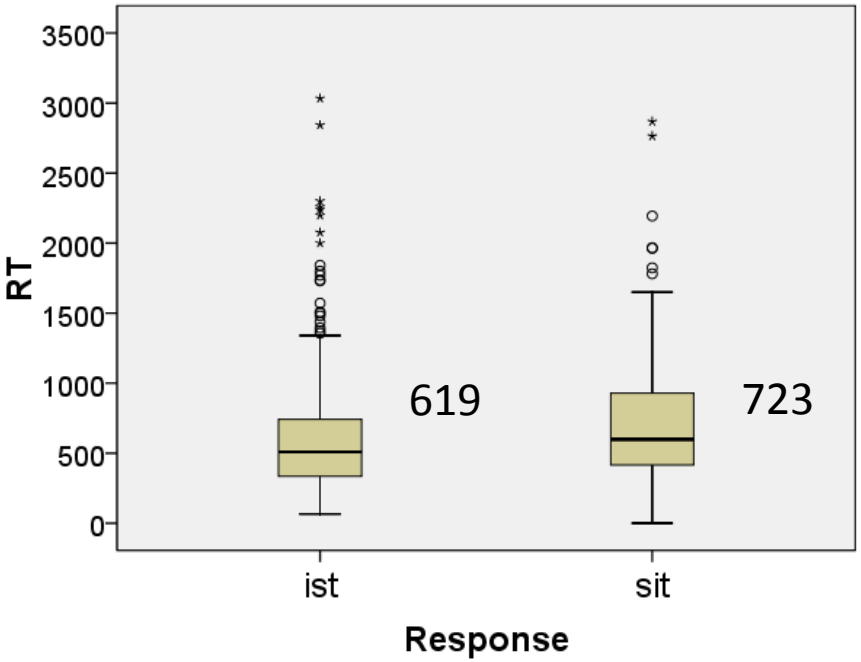
Exp1-Results: RTs

RTs turned out to be extremely variable:
- across participants
- across items

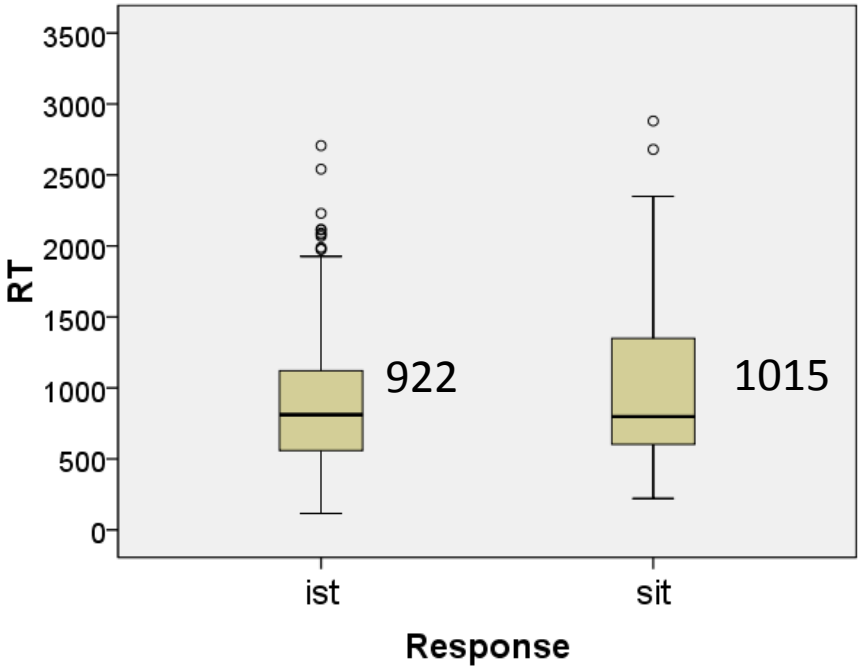


All subjects were faster at giving the IST response than the SIT response (the comparison is significant only for the adult subjects though, $p < .050$):

adults *

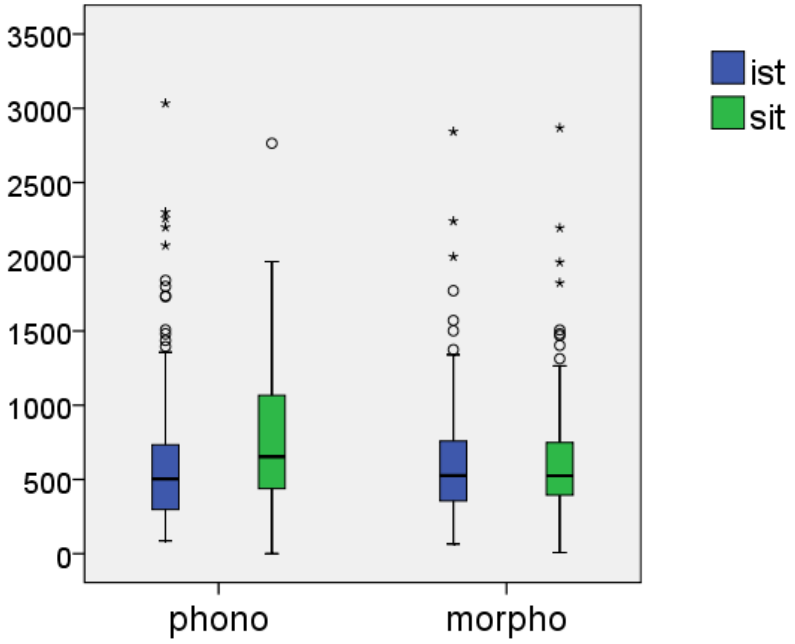


adolescents n.s.

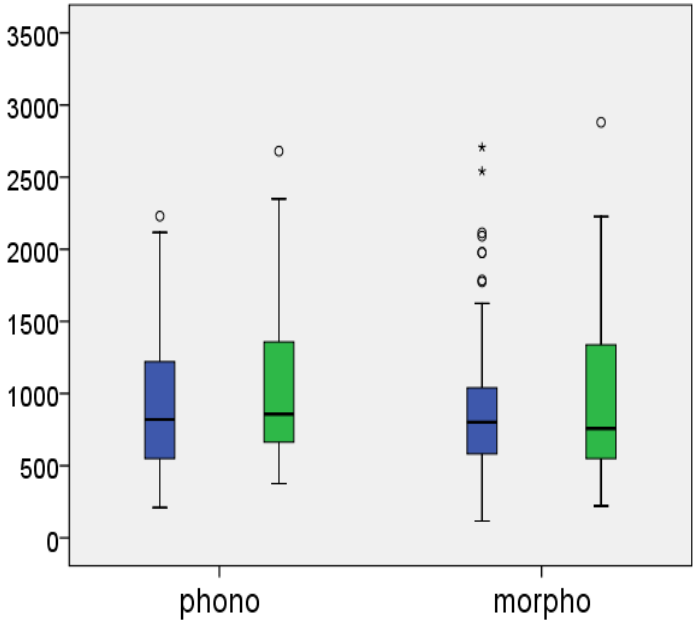


However, there was no particular IST-advantage of MORPHO clusters with respect to PHONO clusters:

adults n.s.

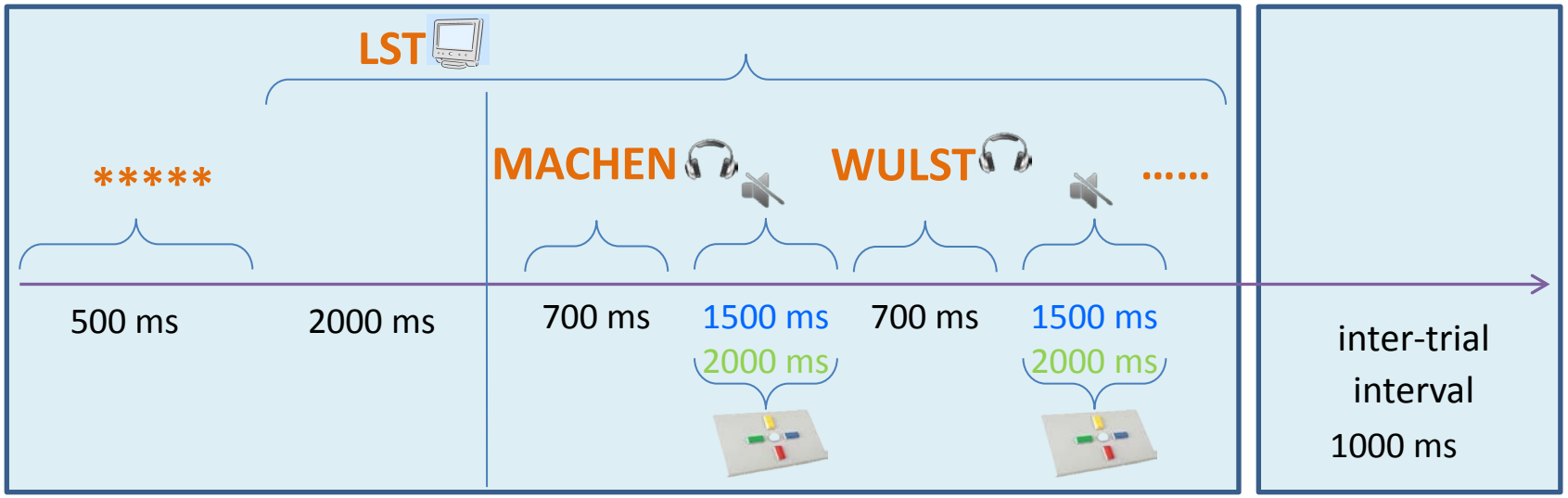


adolescents n.s.



Experiment #2 – Fragment monitoring (slightly modified version)

“Press as soon as possible the green button whenever the heard word contain the target consonant sequence (YES response); press the red one if the heard word does not contain the target sequence (NO response)”.



Button box

Experimental items

		Phonotactic			Morphonotactic			
Cluster type	Position		Frequency	Position		Frequency		
/nst/	w-final	**sonst**	12691	w-final	**schonst**	6		
	w-final	**Wanst**	22	w-final	**kannst**	29709		
	w-final	**Kunst**	31593	w-final	**kennst**	21628		
	w-final	**Gunst**	2715	w-final	**nennst**	155		
	w-internal	**Monster**	983	w-intern	**dünnste**	62		
/pst/	w-final	**Papst**	16971	w-final	**knipst**	113		
	w-final	**Herbst**	3484	w-final	**plumpst**	35		
	w-final	**Obst**	6058	w-final	**gibst**	24740		
/lst/	w-final	**Wulst**	29	w-final	**willst**	3768		
	w-internal	**Elster**	99	w-intern	**prallste**	4		
	w-internal	**Polster**	1431	w-intern	**vollste**	104		
/kst/-/xst/	w-final	**Text**	17026	w-final	**mixt**	215		
	w-internal	**Gangster**	1313	w-intern	**längste**	2423		
	w-final	**Angst**	5737	w-final	**denkst**	694		
	w-final	**Axt**	88	w-final	**sagst**	1069		
Average frequency			***6683***			***5648***		
long vowel								

Frequency calculated as occurrences in *Leipzig Deutscher Wortschaft Online* (500 millions words)

Fragment monitoring (also known as syllable monitoring)
• primarily used to determine which linguistic units are involved in word recognition
• subjects are presented with targets that are either congruent or incongruent with a linguistic unit in the target-bearing item
• congruent targets → faster detection latencies
• for example, subjects are faster to detect a target when it corresponds to the first syllable of the carrier than when it corresponds to more or less than the first syllable → perceptual relevance of the syllable

Prediction:
Since MORPHO clusters are incongruent with linguistic units (=morphemes), they will be longer and less accurate to detect than PHONO clusters (which are neutral with respect to morpheme segmentation)

Analysis:
accuracy (= number of errors in cluster detection)
RTs

2 groups of native Austrian German speakers:
42 adults vs.
26 adolescents (< 16 y.o.)

Exp2 - Results: accuracy

Errors distribution overall

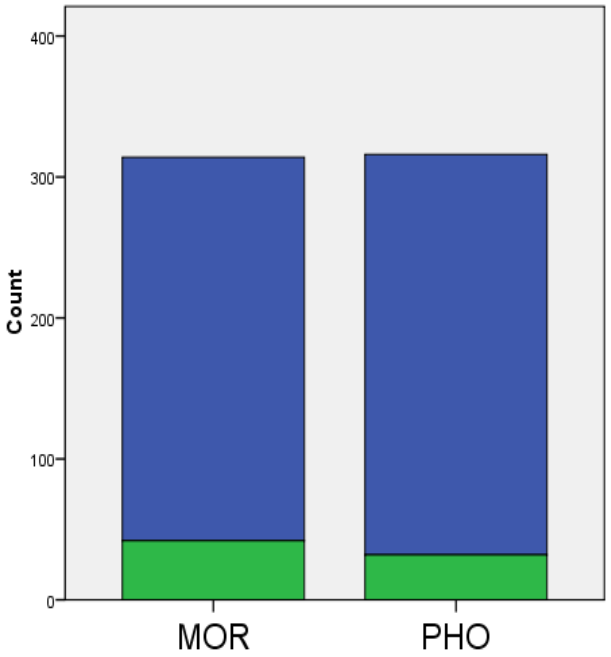
- Adolescents > adults
- experimental items > fillers

	Adult % error	**Adolescent % error**
Experimental items	**11.7**	**21**
All dataset	**3.5**	**5.9**

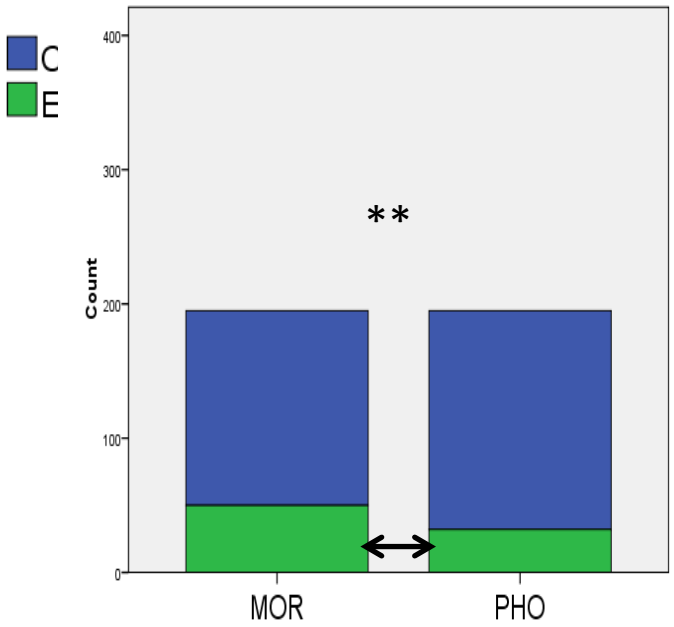
Results: accuracy

In both adult and adolescent performance, MORPHO clusters are more difficult to detect than PHONO counterparts.
However, the pattern is significant for adolescent only.

adults



adolescents

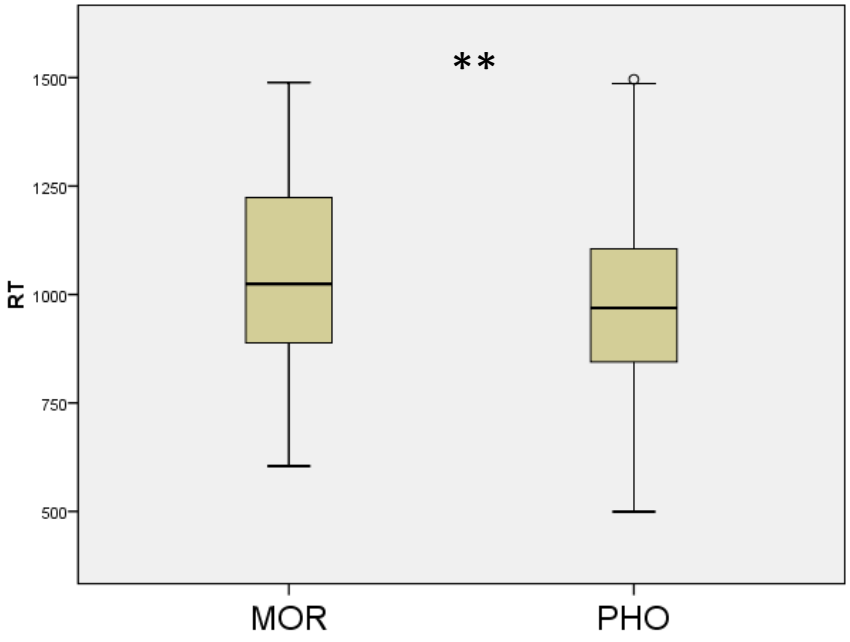


Exp2-Results: RTs

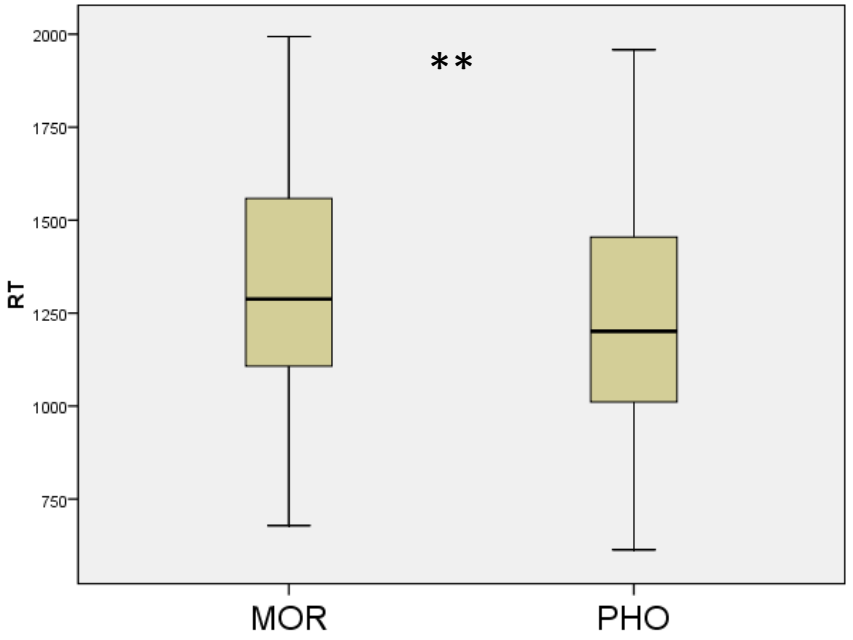
Only correct responses considered (adults, N = 556; children N = 308)

All subjects were faster at detecting PHONO clusters than MORPHO clusters; the comparison is significant for both adult and adolescents

adults



adolescents



Summary of the results

	Exp #1 "Split- cluster" test		Exp #2 Sequence monitoring	
	Adolescent	Adult	Adolescent	Adult
MORPHO clusters easier to split	**yes**	slight tendency		
MORPHO clusters more frequently split according to the "IST" option	**yes**	**no**		
MORPHO clusters faster to split	**no**	**no**		
PHONO clusters easier to detected			**yes**	slight tendency
PHONO clusters faster to detect			**yes**	**yes**

Empirical limitations imposed to the study of online processing of (mor)phonotactic clusters

- cluster distribution in the lexicon is strongly idiosyncratic, and frequency effects are hard to avoid
- appropriate experimental procedures not easy to find (cannot use non-words!)

Nevertheless, the two experiments allow some tentative conclusions, at least for the following aspects:

- In processing MORPHO clusters, the speakers rely on the presence of the internal morphological boundary:
  I. MORPHO clusters are easier to split
  II. monitoring MORPHO clusters requires greater effort/longer time
- Adolescents seem to be more sensitive to cluster (mor)phonotactic status than adults

Future studies

Non-exclusively morphonotactic clusters (e.g. German /-l(#)st/)

- Are they differently processed with respect to their phonotactic homophonous counterparts?
- Are there two different phonotactic 'representations' for homophonous C#CC vs. CCC clusters?
- Are there acquisitional preferences?
- **Do speech production strategies change for C#CC vs. CCC?**

In preparation: "Nasal place assimilation in complex words as a function of morphosemantic transparency. An EPG study of German and Italian"

with Sylvia Moosmueller and Silvia Calamai