

“TA-DA!”

DIRECTIONAL ASYMMETRY IN THE BRAIN'S PERCEPTION OF SPEECH SOUNDS:  
AN MMR STUDY OF [t] VS. [d]

Bias in Auditory Perception  
Aarhus, Sept 18, 2014

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# WHY

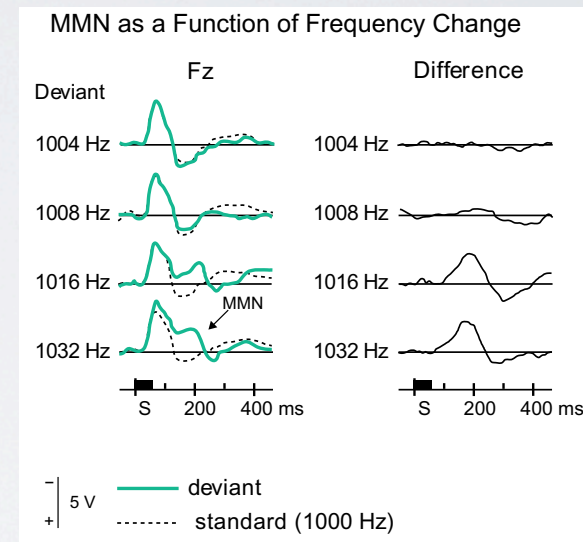
Mismatch response (MMR) to allophonic vs. phonemic processing for one and the same phonetic contrast

To test the effect of a potential directional asymmetry for a consonant contrast on the MMR

# MISMATCH RESPONSE

## Oddball paradigm

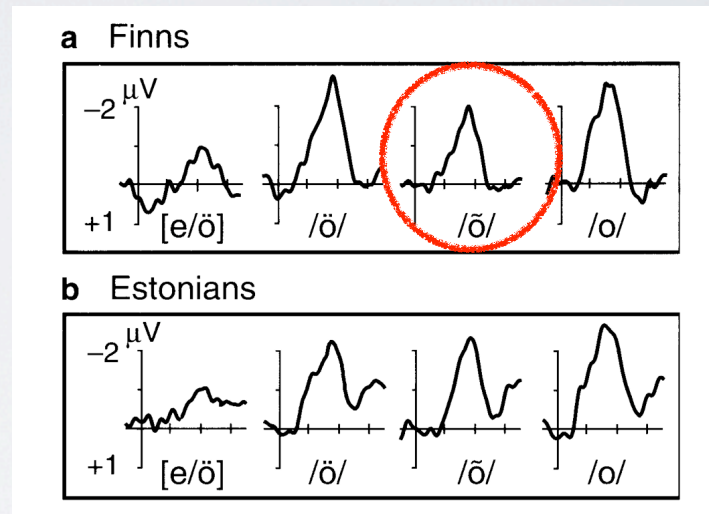
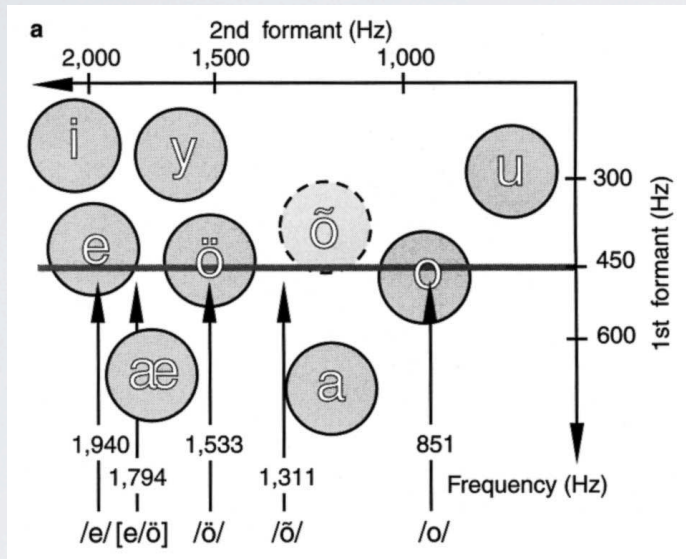
s = standard tone  
d = deviant tone



Näätänen *et al.* (2007)

[ ... s s s s s s s s s s s s s s s s d s s s s s d s s s s s d s s s s s d s s s s s s s s s s d s s s s ... ]

# MMR AND LANGUAGE



Näätänen *et al.* (1997)

# MMR AND LANGUAGE

Larger MMR to native (phonemic) than to non-native (non-phonemic) phones: Chládková, Escudero, & Lipski, 2013; Dehaene-Lambertz, 1997; Dehaene-Lambertz, Dupoux, & Gout, 2000; Kazanina, Phillips, & Idsardi, 2006; Kirmse et al., 2007; Kuhl et al., 1992; Miglietta, Grimaldi, & Calabrese, 2013; Näätänen et al., 1997; Noordenbos, Segers, Serniclaes, & Verhoeven, 2013; Phillips et al., 2000; Sharma & Dorman, 2000

# MMR AND SYMMETRY IN NON-SPEECH SOUNDS

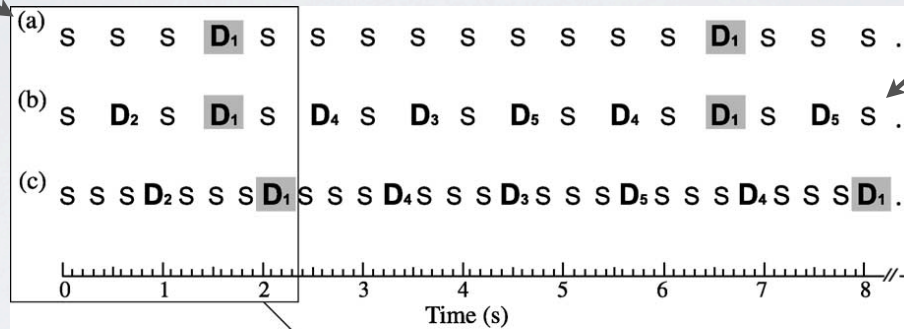
No differences in MMR regardless of direction:

Näätänen, 1992; Kaukoranta et al., 1989; Jaramillo, Paavilainen & Näätänen, 2000

# MMR PARADIGMS

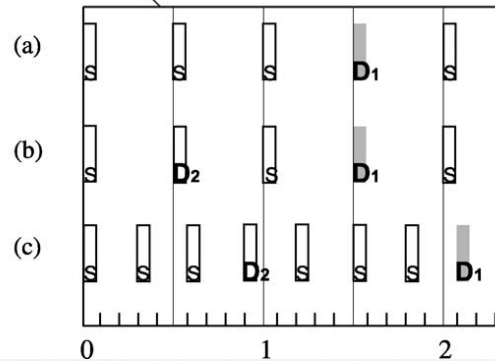
classical oddball paradigm:

time-consuming  
only 1 contrast  
very monotone



new improved multi-feature paradigm (aka. Optimum I):

less time-consuming  
4-5 contrasts  
more varied



# STIMULI

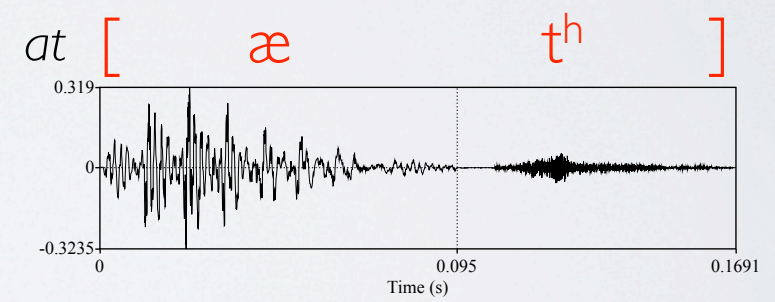
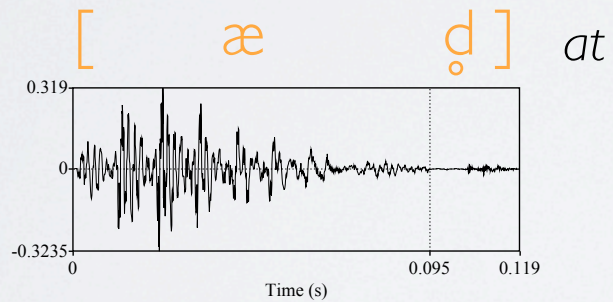
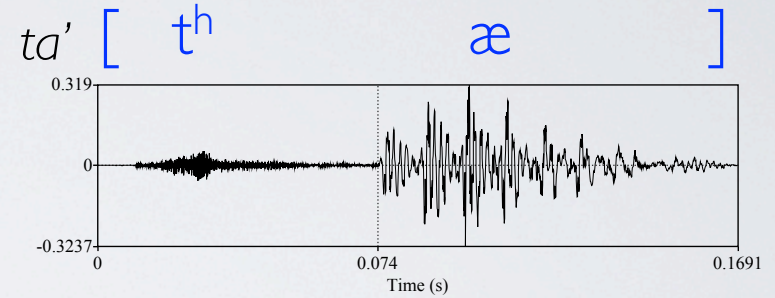
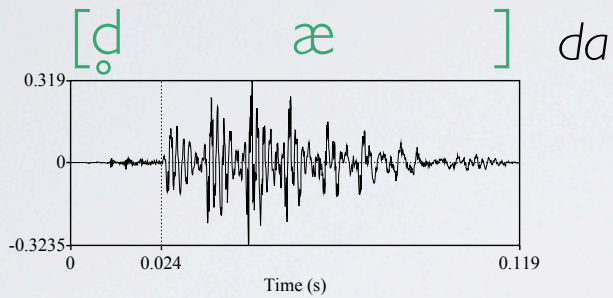
	unvoiced [d̥]	aspirated [tʰ]
phonemic [-æ]	[dæ] <i>(then)</i>	[tæ] <i>(take)</i>
allophonic [æ-]	[æd] <i>(that)</i>	[æt] <i>(that)</i>



# STIMULI

$[t^h-]$   $\approx$  74 ms  
 $[d-]$   $\approx$  24 ms  
diff  $\approx$  50 ms

$[\text{æ}]$   $\approx$  95 ms



# PARADIGM

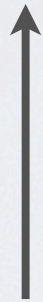
Multi-feature MMN/MMF paradigm (Optimum 1)		...	S	D <sub>1</sub>	S	D <sub>2</sub>	S	D <sub>3</sub>	S	D <sub>4</sub>	...
<b>A</b>	<b>Phonemic</b> target deviant = [dæ]	...	[tæ]	[dæ]	[tæ]	[te]	[tæ]	[æt]	[tæ]	[TÆ]	...
<b>B</b>	<b>Phonemic</b> target deviant = [tæ]	...	[dæ]	[tæ]	[dæ]	[de]	[dæ]	[æd]	[dæ]	[DÆ]	...
<b>C</b>	<b>Allophonic</b> target deviant = [æd]	...	[æt]	[æd]	[æt]	[et]	[æt]	[tæ]	[æt]	[ÆT]	...
<b>D</b>	<b>Allophonic</b> target deviant = [dæ]	...	[æd]	[æt]	[æd]	[ed]	[æd]	[dæ]	[æd]	[ÆD]	...

# HYPOTHESES

No differences in MMR

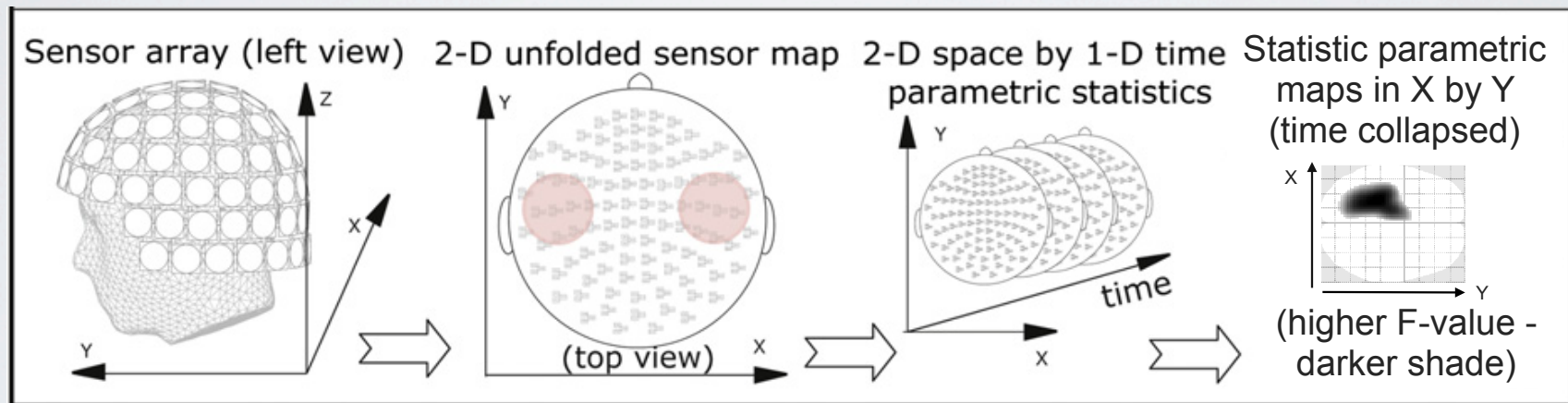
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Larger MMR for  
the phonemic contrast

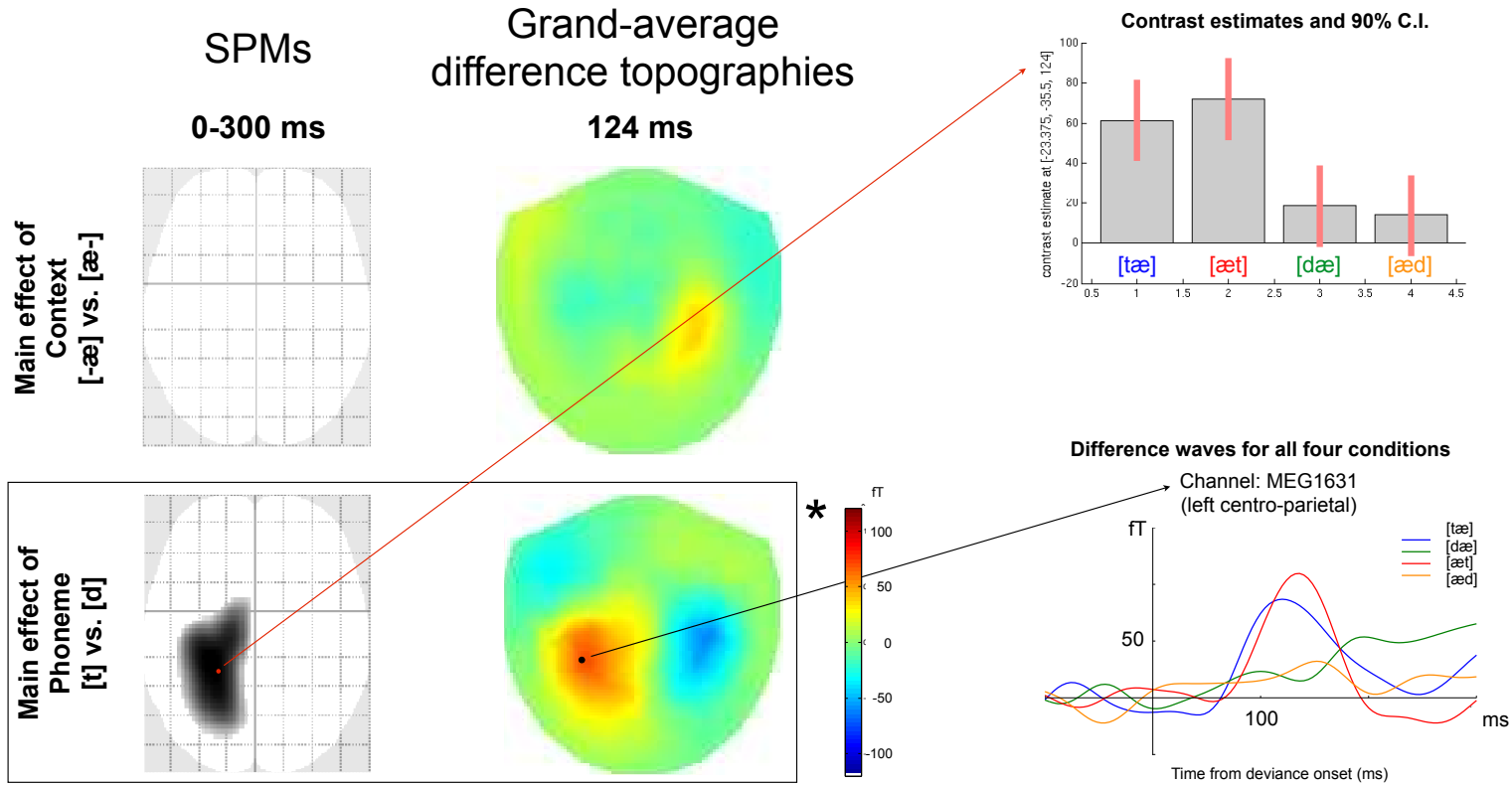


	unvoiced [d̥]	aspirated [tʰ]
phonemic [-æ]	[dæ] <i>(then)</i>	[tæ] <i>(take)</i>
allophonic [æ-]	[æd] <i>(that)</i>	[æt] <i>(that)</i>

# ANALYSES



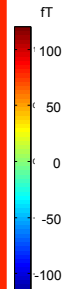
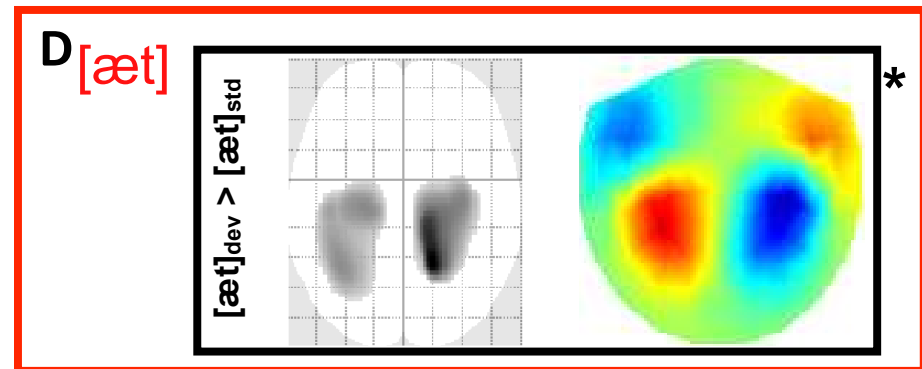
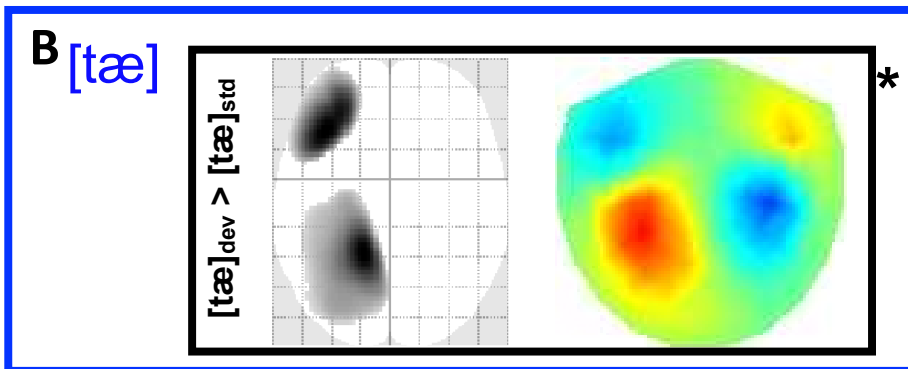
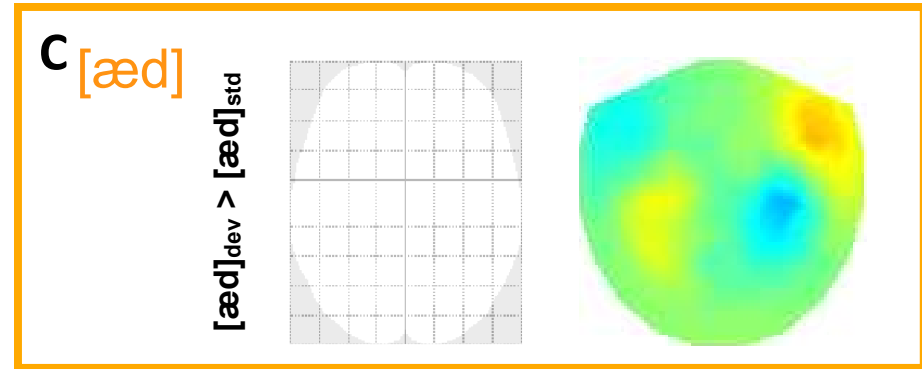
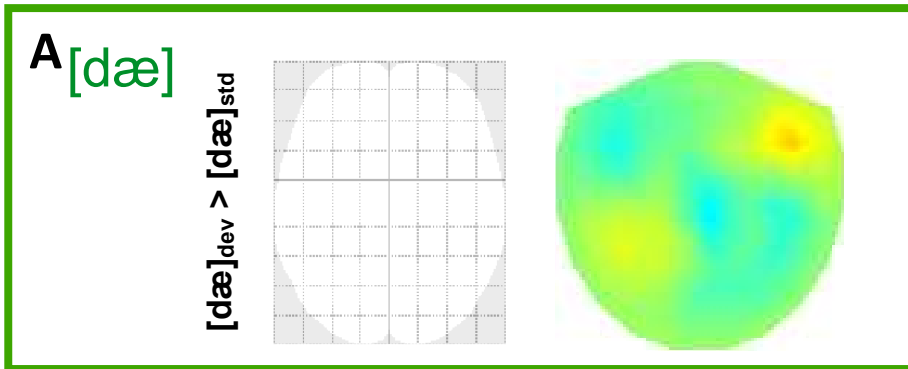
# RESULTS - MEG



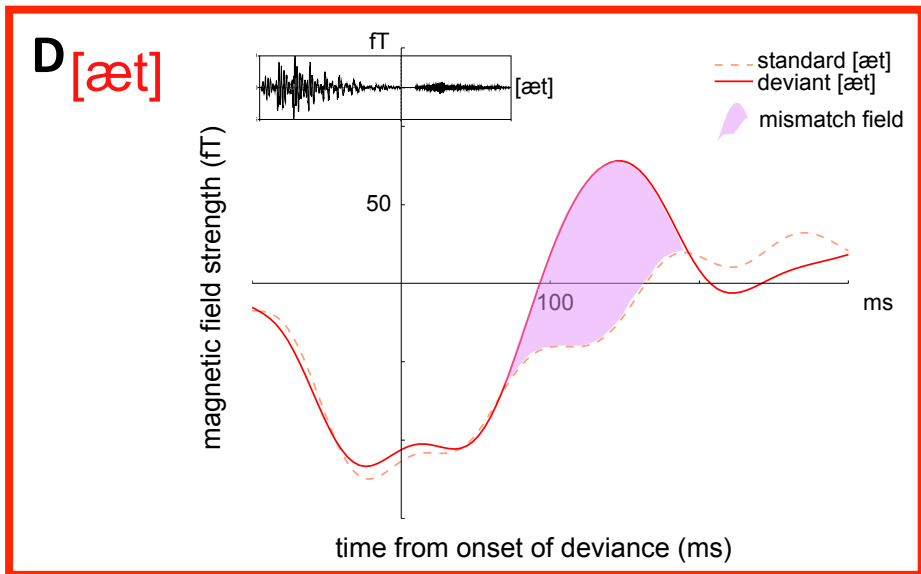
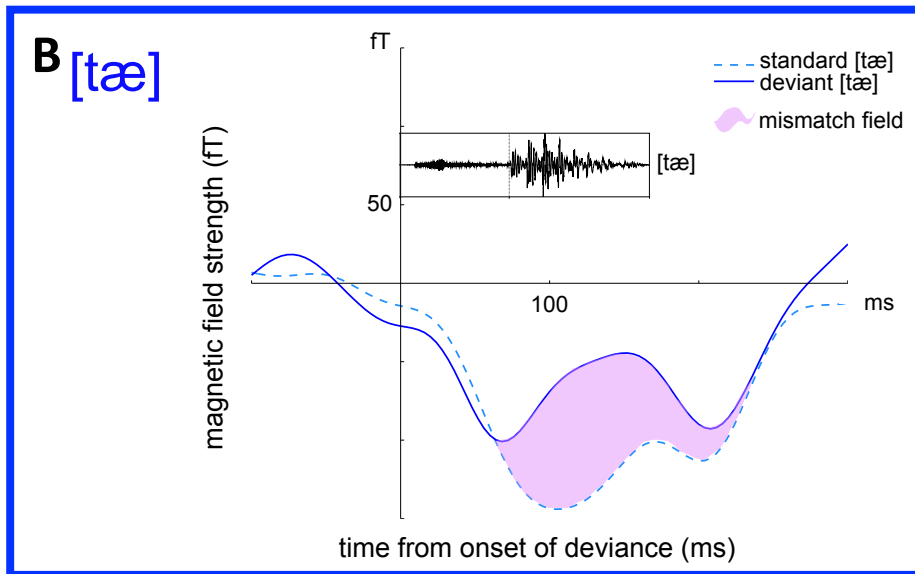
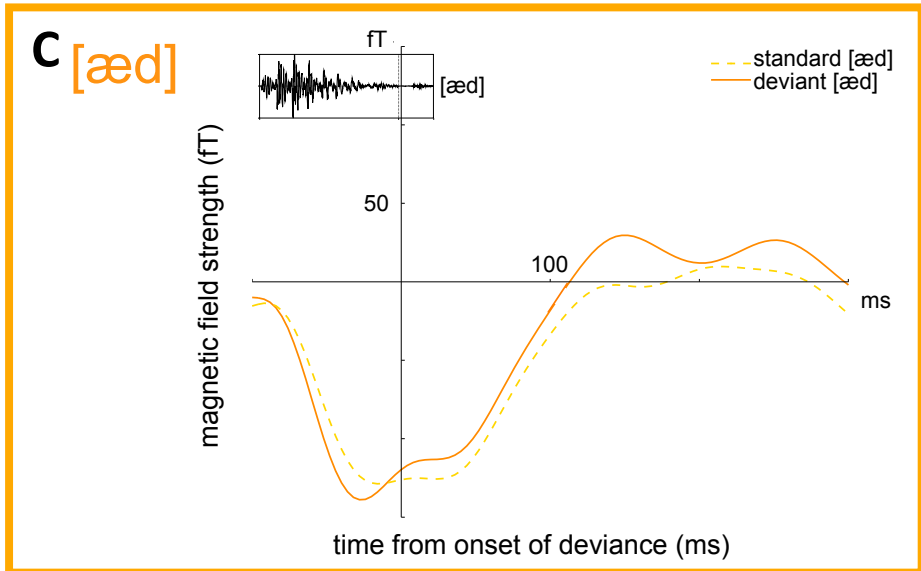
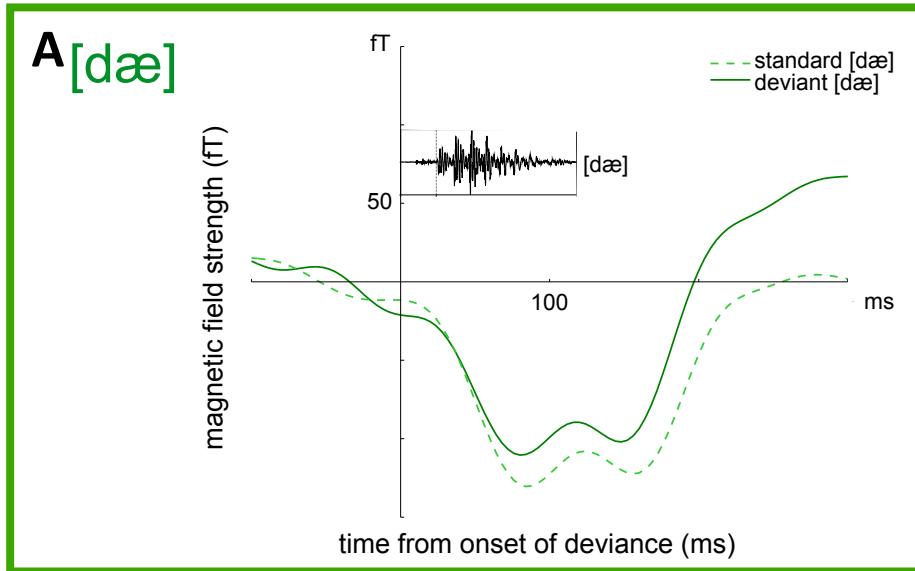
# MEG

SPMs  
0-300 ms  
Grand-average  
difference topographies  
124 ms

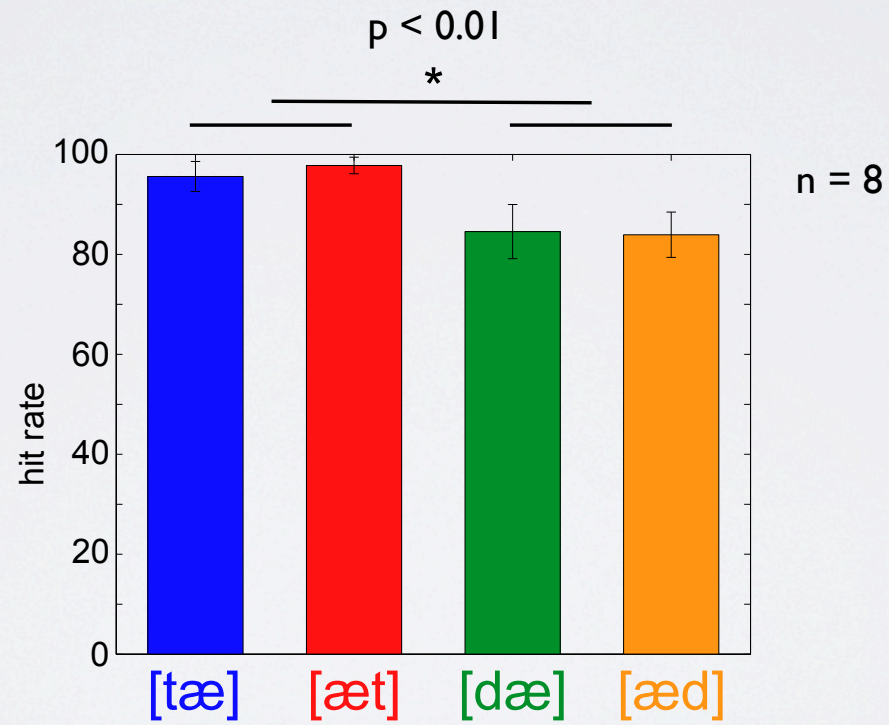
SPMs  
0-300 ms  
Grand-average  
difference topographies  
124 ms



Channel: MEG1631 (left centro-parietal)



# BEHAVIORAL





# DISCUSSION

## Featurally Underspecified Lexicon (FUL):

Lahiri & Reetz, 2002; Eulitz & Lahiri, 2004; Scharinger et al., 2010

## Perceptual asymmetry for vowels (and the NRV):

Polka & Bohn, 2003; Polka & Bohn, 2010

# DISCUSSION

Differences in MMR in relation to perceptual asymmetries in speech perception (mainly vowels): Eulitz & Lahiri, 2004

From posters: Vera-Constán & Sebastián-Gallés, 2008; Hestvik, Durvasula, Bradley & Bradley, 2009; Durvasula & Hestvik, 2012; Roberts, Kotzor, Wetterlin & Lahiri, 2014; Schluter, Politzer-Ahles & Almeida, 2014

# CONCLUSION

Directional asymmetry in the brain for a consonant contrast

We could not show an effect of allophonic/phonemic status on the MMR  
using one and the same phonetic contrast

# THANKS TO

My collaborators:

Line Gebauer, Bill McGregor and Mikkel Wallentin,

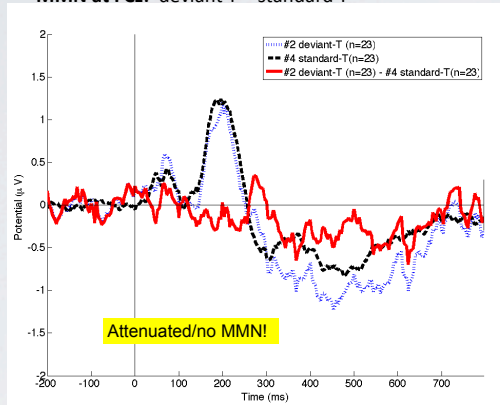
and

Mirjam de Jonge, Kevin Schluter and Ocke-Schwen Bohn  
for insightful comments

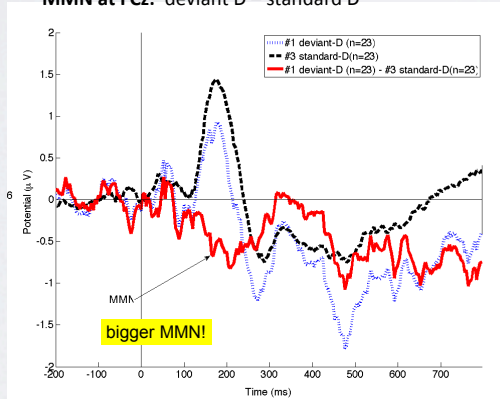
AND  
THANK YOU  
FOR LISTENING

# Durvasula & Hestvik, 2012

MMN at FCz: deviant T – standard T

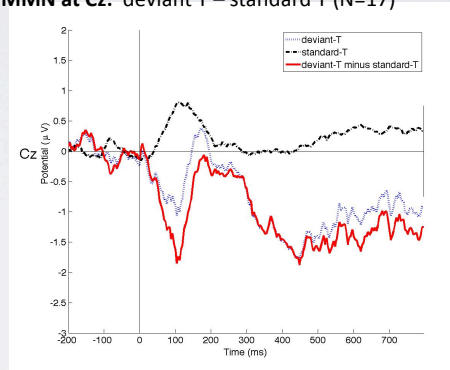


MMN at FCz: deviant D – standard D

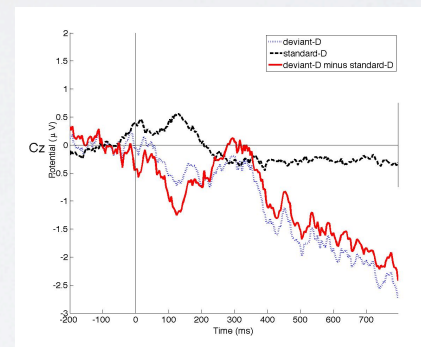


Using the finding from Experiment 1 of block order effect::

MMN at Cz: deviant T – standard T (N=17)



MMN at Cz: deviant D – standard D (N=16)



FINDING: Not the same asymmetry between /d/ and /t/ in phonetic paradigm.