

# Intrinsic and Prosodic Effects on Articulatory Coordination in Initial Consonant Clusters

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## **Two topics:**

(1) “Intrinsic”

(2) “Prosodic”

## **(1) “Intrinsic”**

i.e segmental make-up of clusters

Compare articulatory coordination in e.g /kl/ vs. /kn/

Cross-language differences in coordination

## **(2) “Prosodic”**

Is articulatory coordination in clusters affected

by prosodic boundaries of different strengths?

by location of lexical stress?

## **(1) “Intrinsic” effects. More background**

What makes a good cluster?

A good compromise between

parallel transmission of segmental information, i.e large overlap

====> efficient for speaker

clear modulation of acoustic signal

====> efficient for listener

cf. Chitoran et al., (2002), LabPhon 7

Specifically ...

Are sequences of **plosive + nasal**  
less suitable as a complex onset than **plosive + lateral**?

Some synchronic and diachronic indications

Why?

Large overlap of plosive and nasal may compromise characteristics of plosive burst

====> phonotactic restrictions in French

plosive+lateral can be followed by glide, but not plosive+nasal

Can constraints of this kind interact with

the voicing of the plosive (C1)?

the realization of voicing across languages?



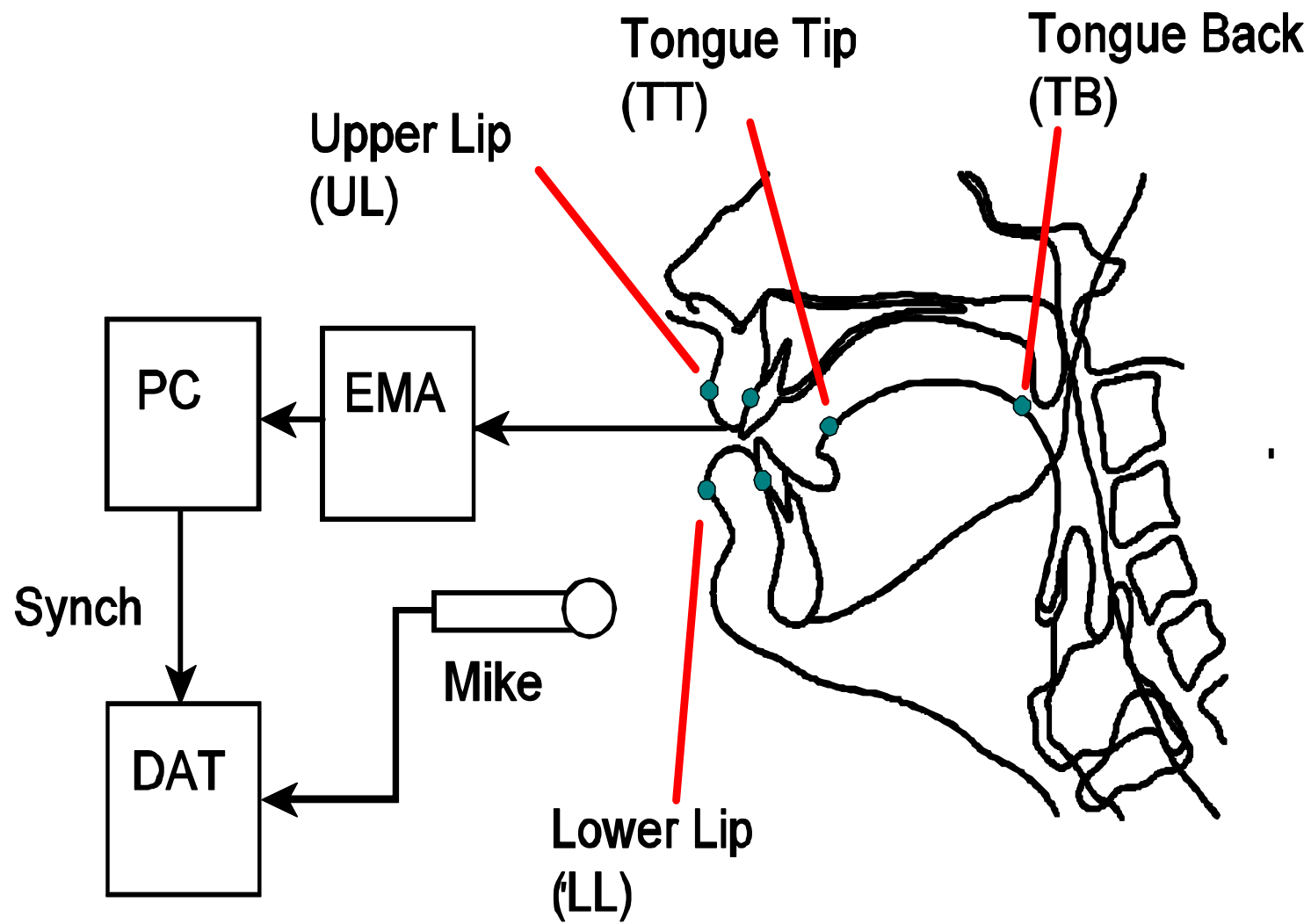
## Corpus

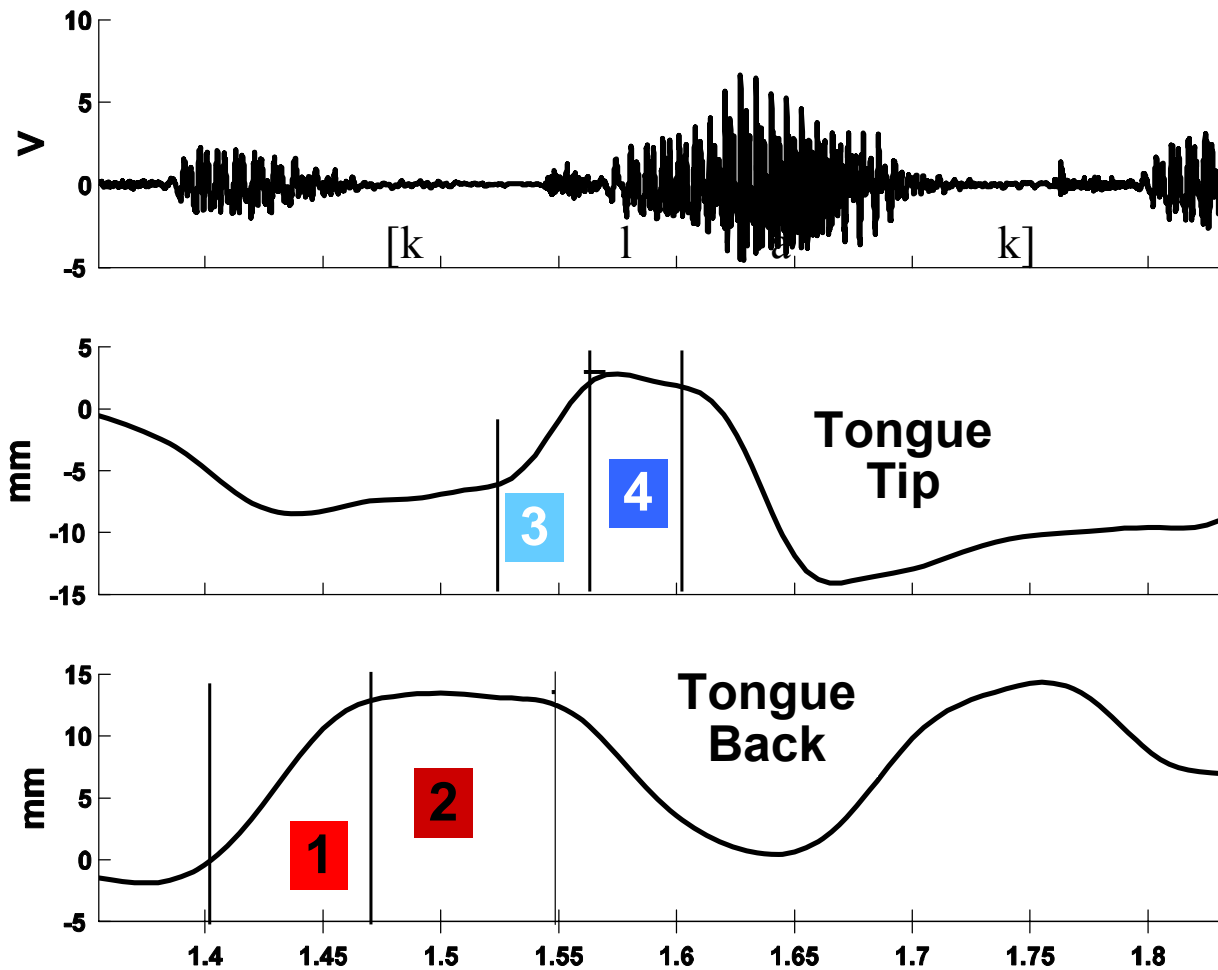
EMA recordings of all syllable onsets of French and German.

Here, only **C1 = / p, b, k, g/** combined with **C2 = /l, n/** will be considered

(note: /bn/ not found in either language)

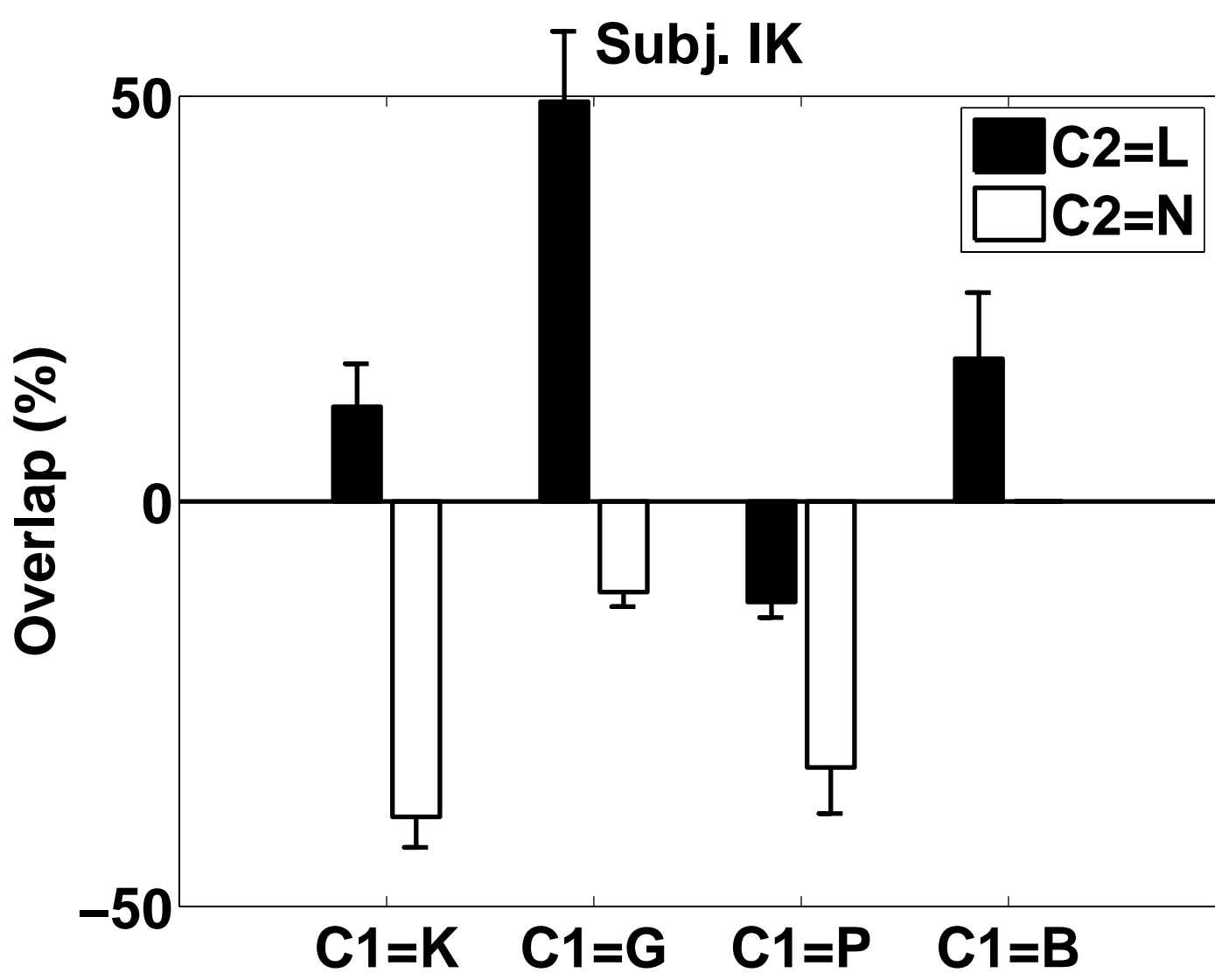
To date, 3 speakers each of German and French have been analyzed.

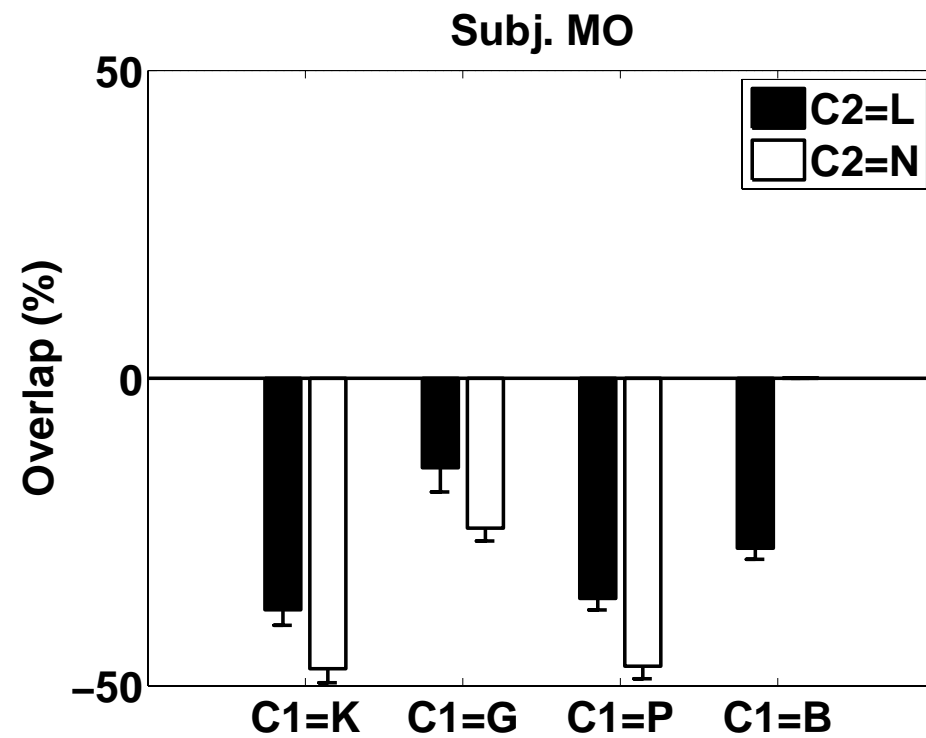
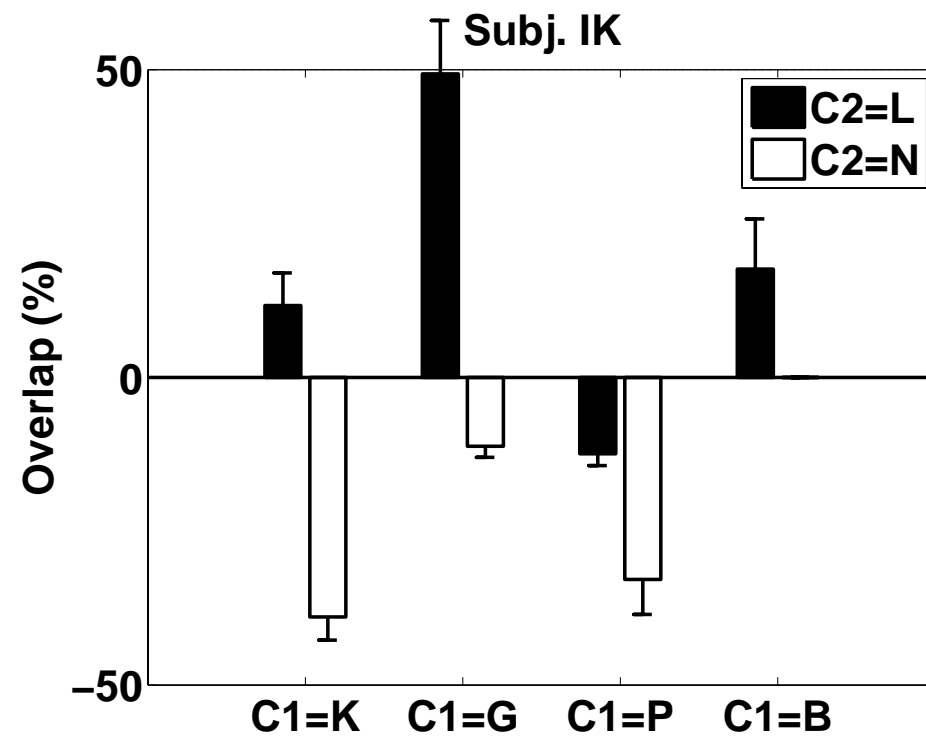
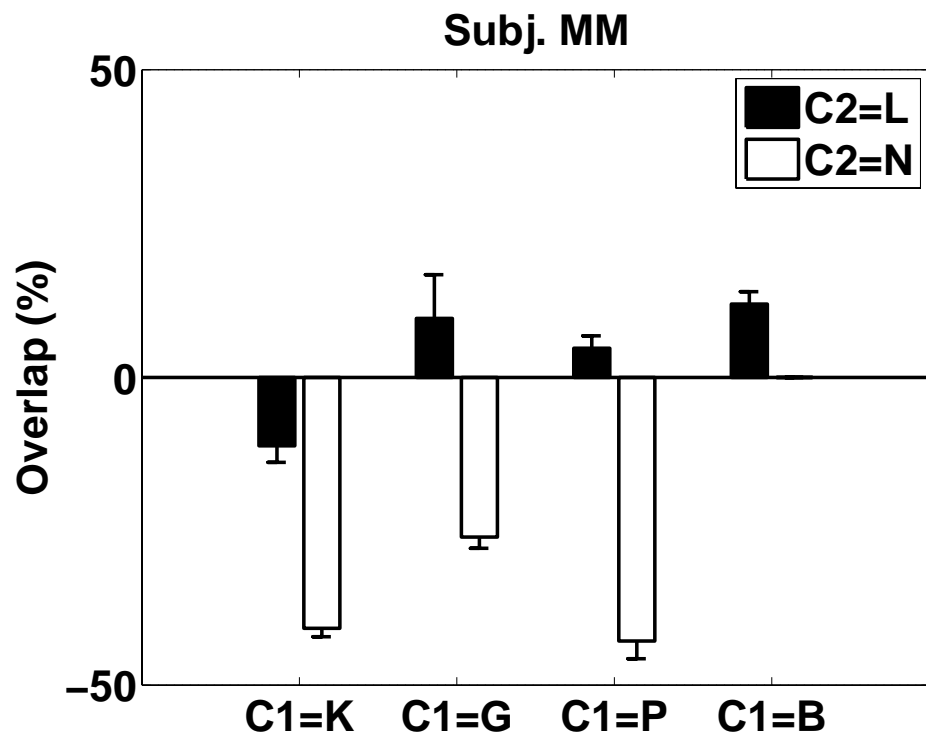




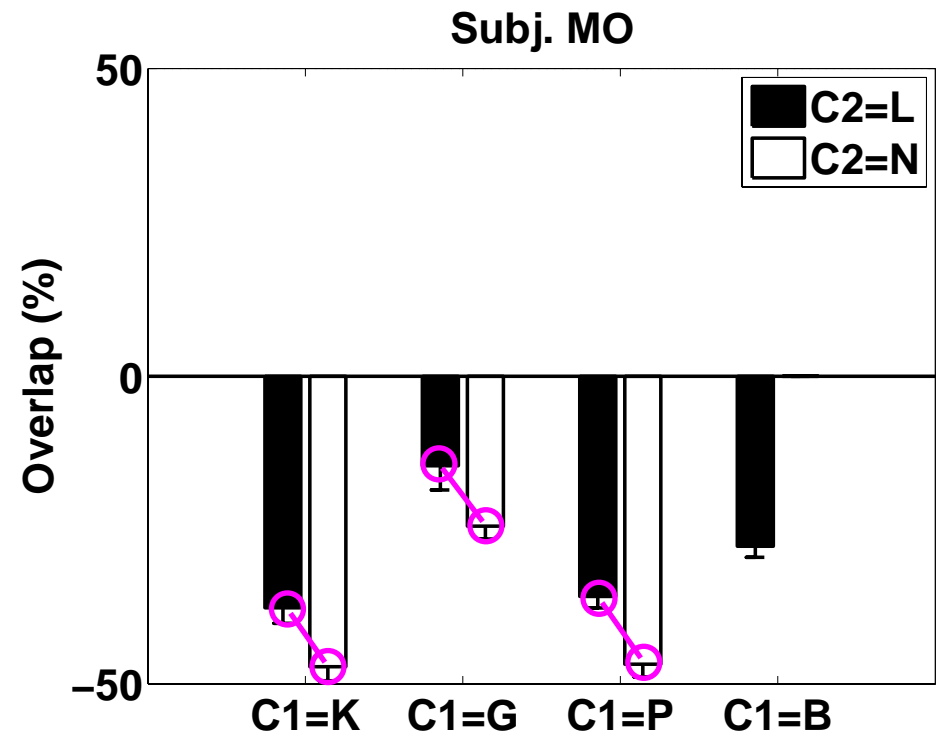
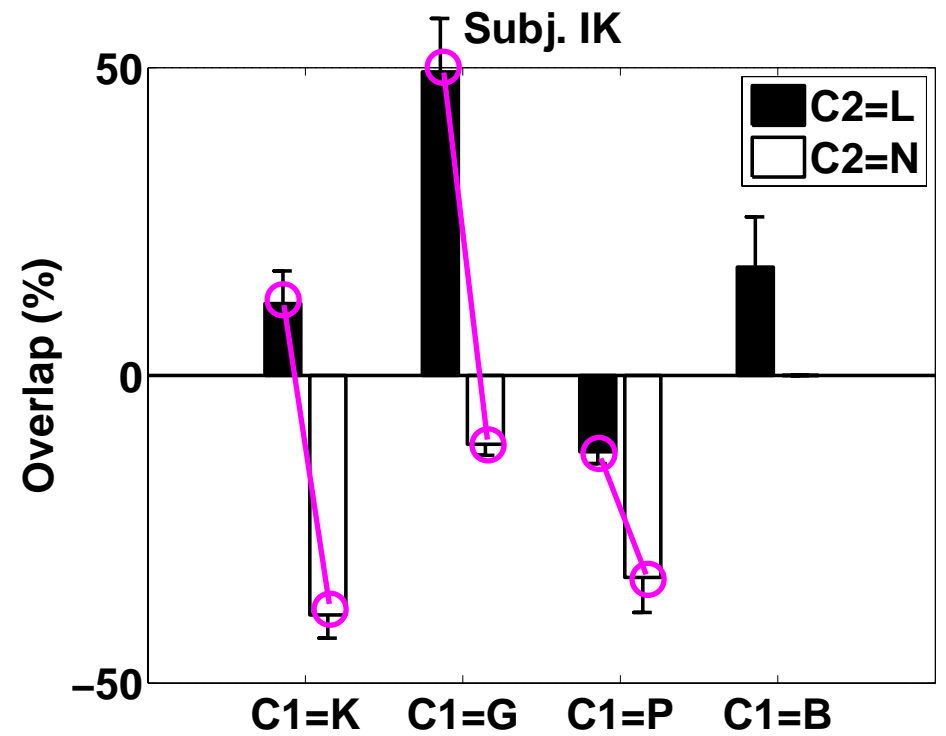
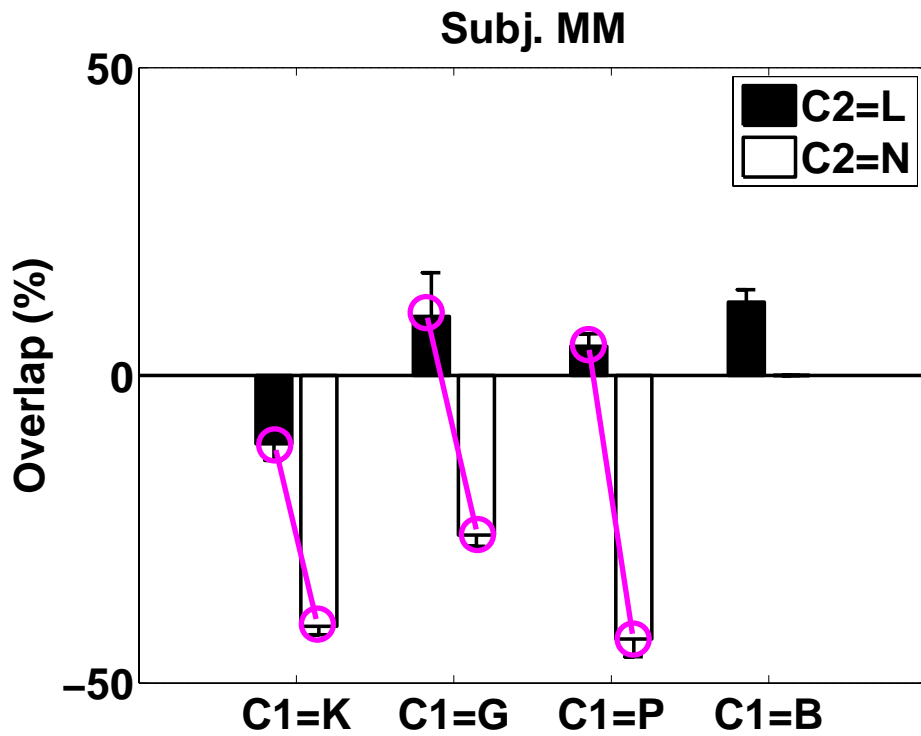
$$\text{Overlap (normalized \%)} = ((\text{Offset}_2 - \text{Onset}_4) / (\text{Offset}_4 - \text{Onset}_2)) * 100$$

More positive values indicate more overlap of Phase 2 and Phase 4



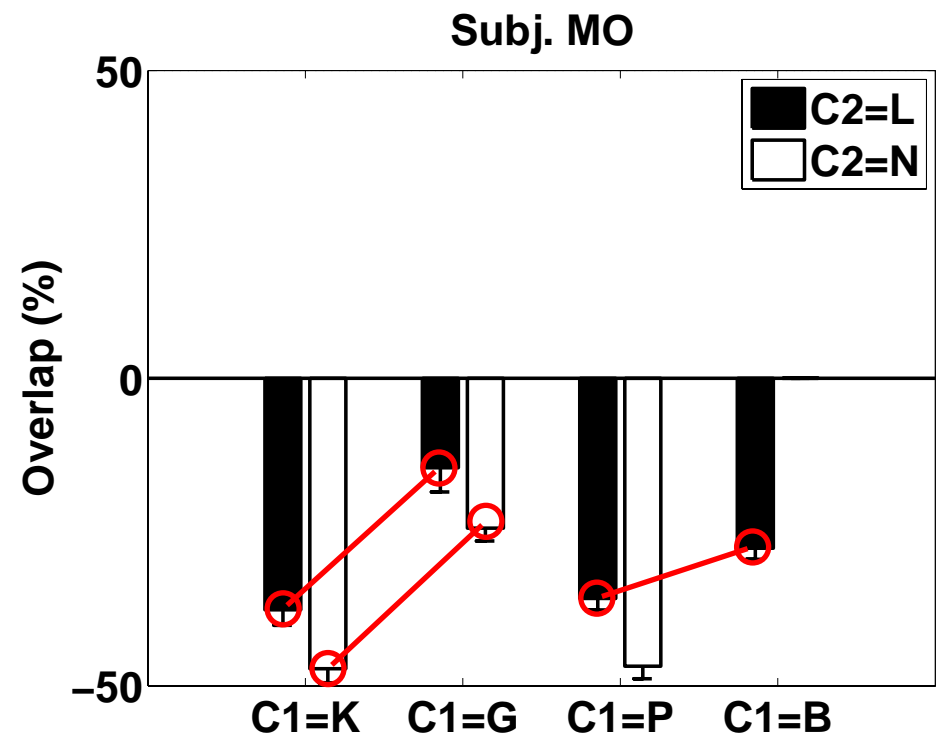
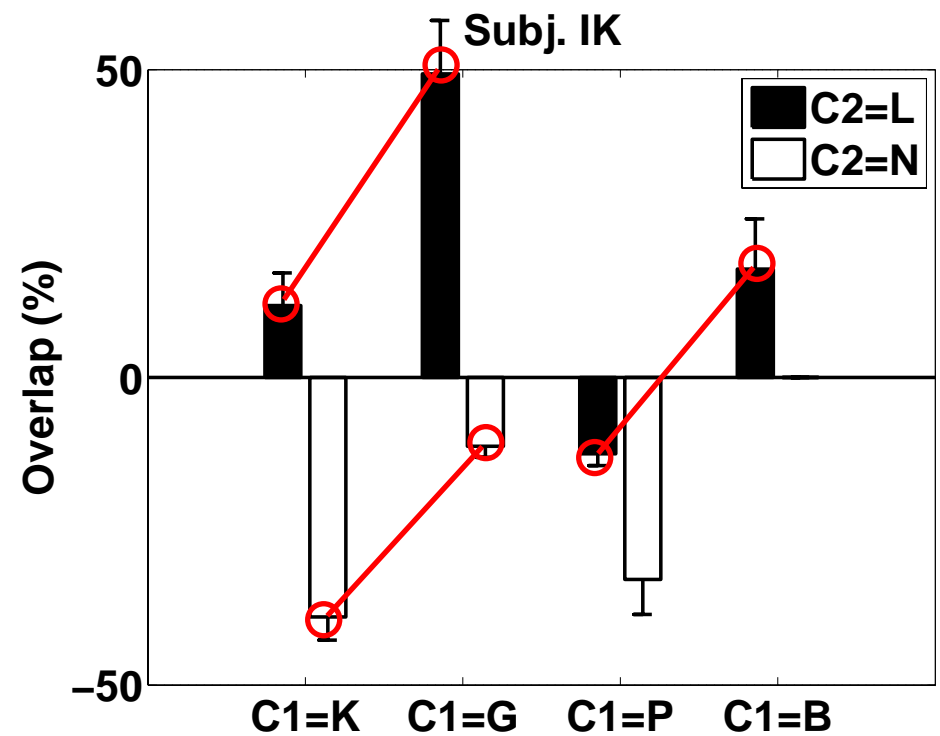
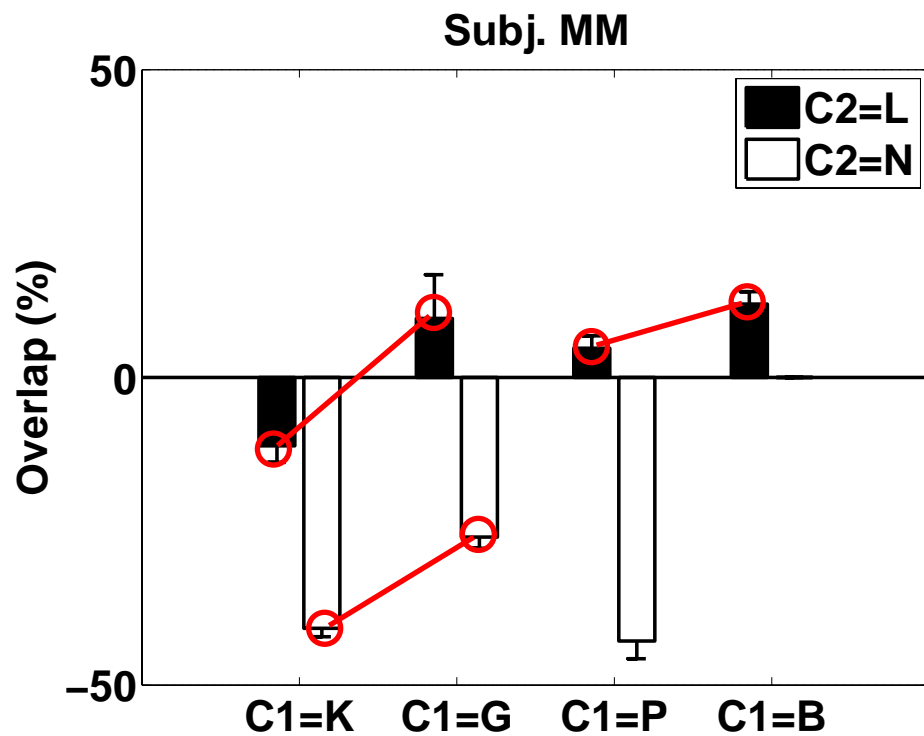


**Results: German**



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Consistently more overlap for  
 C2 = L (black bars)  
 than for  
 C2 = N (white bars)



## Results: German

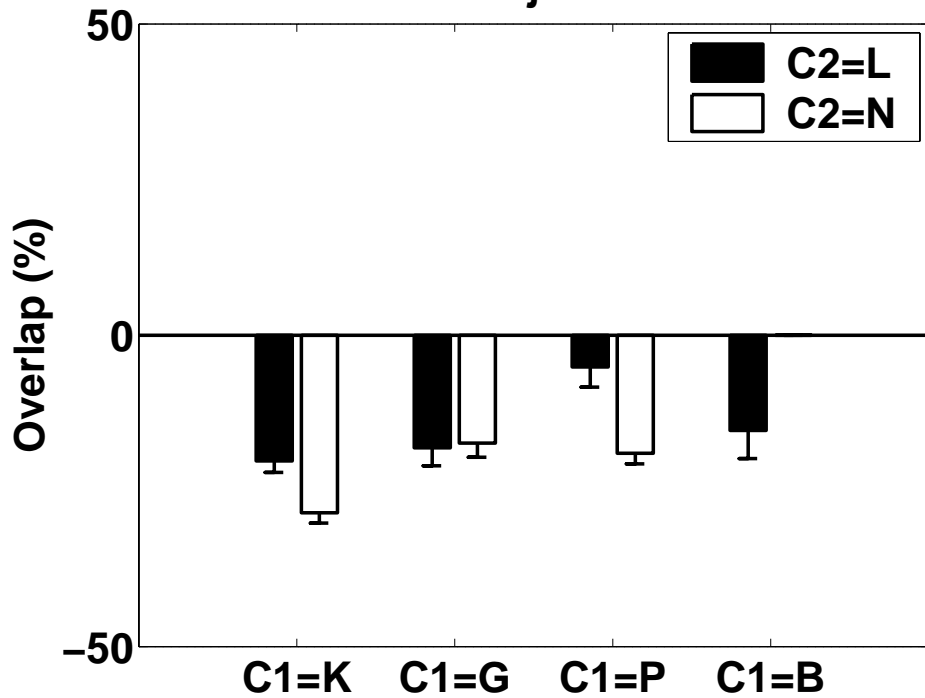
Consistently more overlap for

C1 = Voiced (G, B)

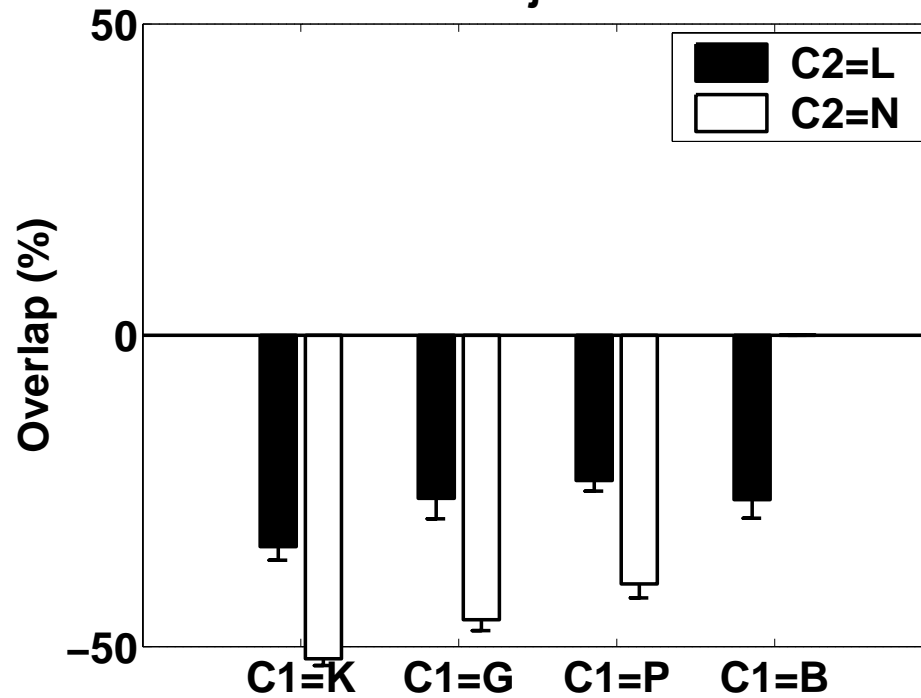
than for

C1 = Voiceless (K, P)

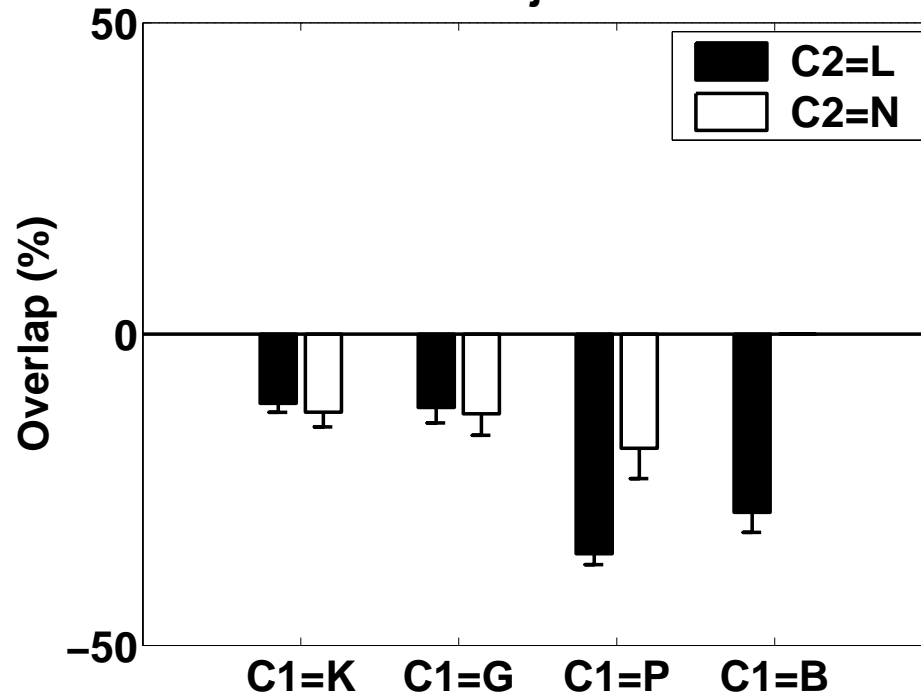
Subj. NN



Subj. AM

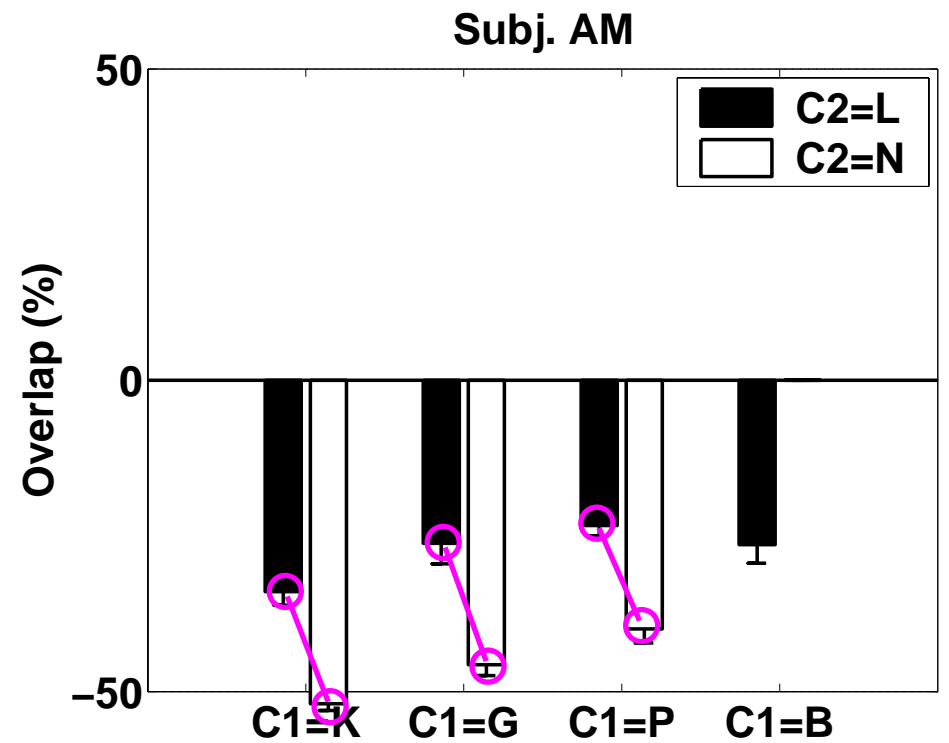
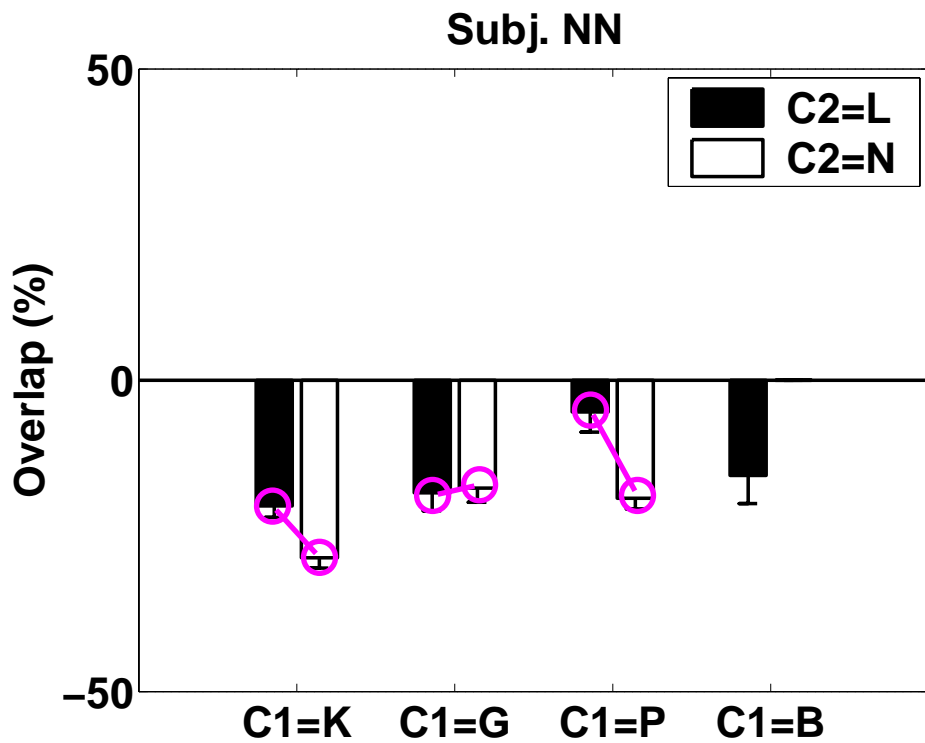


Subj. CG



Results: French





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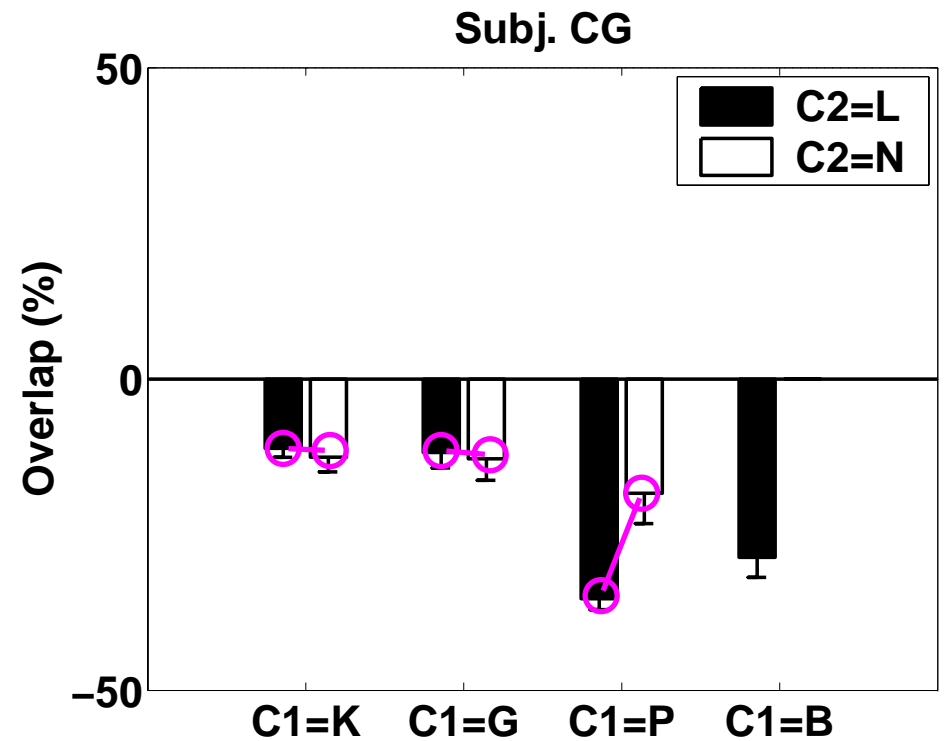
Overall more overlap for

C2 = L (black bars)

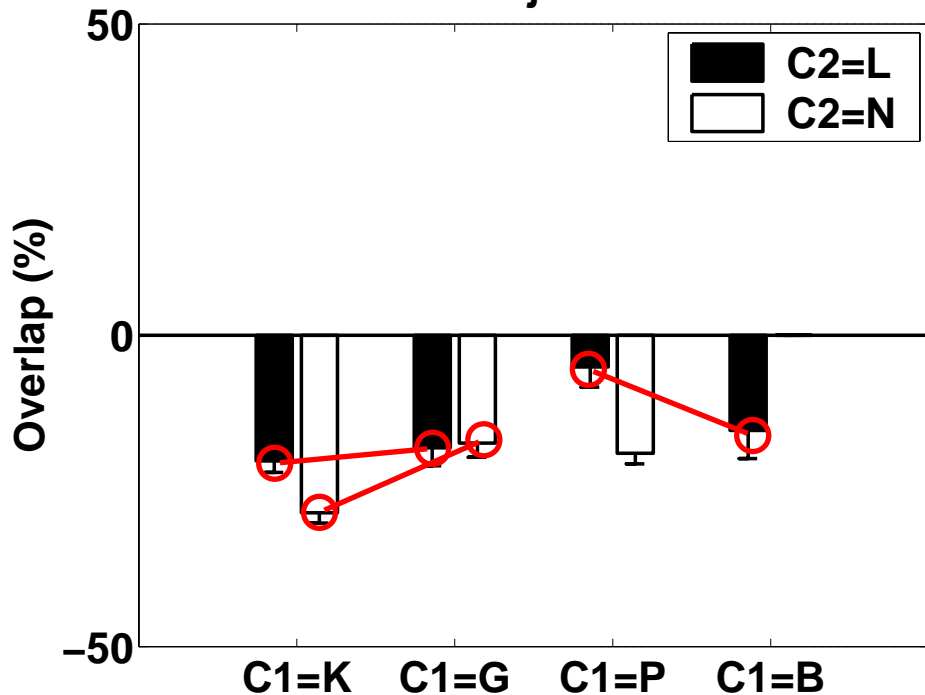
than for

C2 = N (white bars)

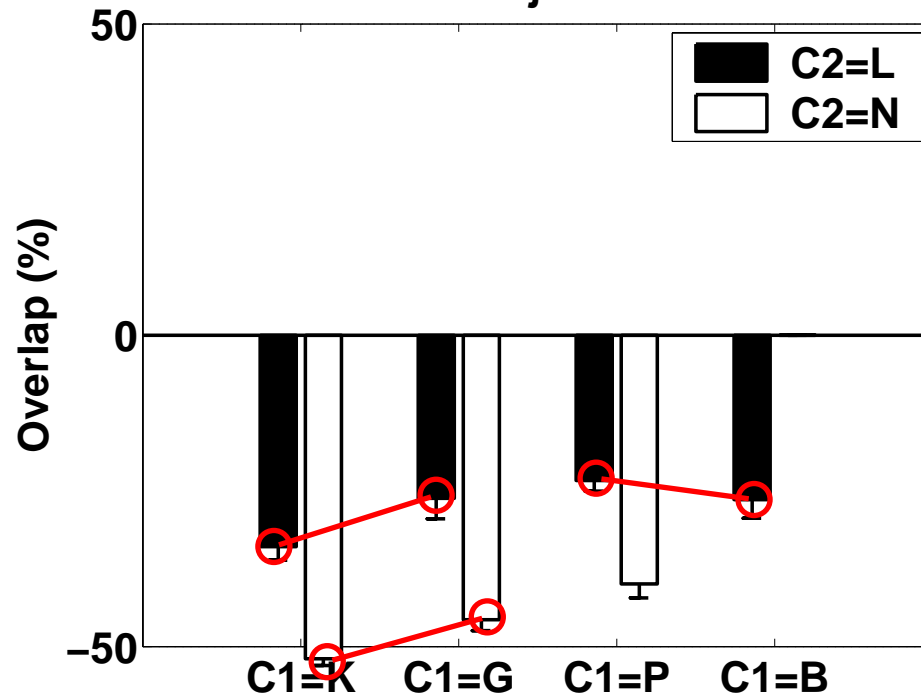
(but less consistent than German)



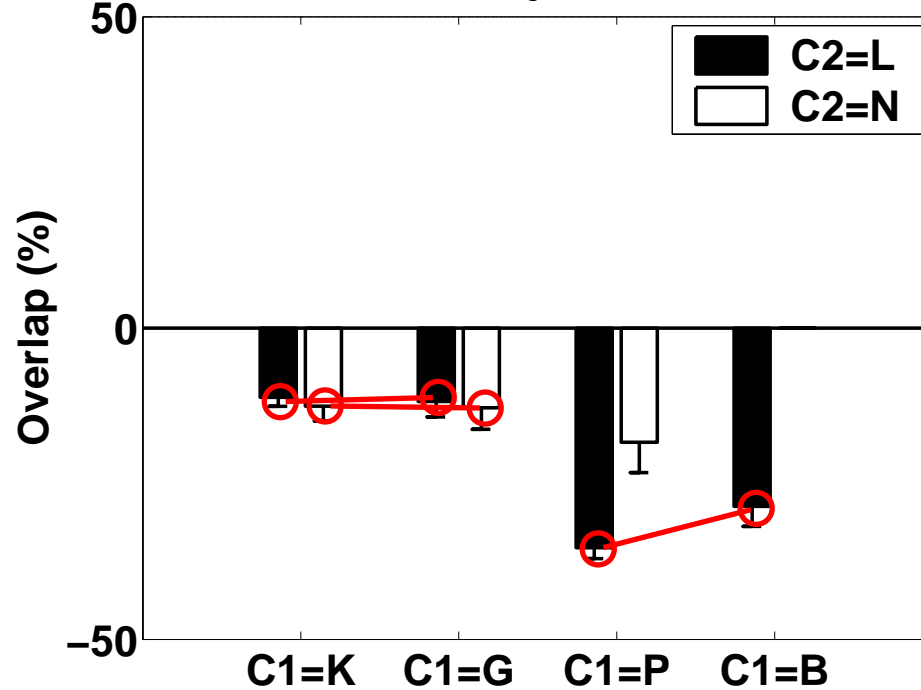
Subj. NN



Subj. AM



Subj. CG



## Results: French

No clear trend for

C1 = Voiced (G, B)

vs.

C1 = Voiceless (K, P)

(unlike German)

## Summary (part 1)

- (1) Clear preference for more overlap in plosive+lateral than in plosive+nasal. More pronounced in German than French
- (2) In German more overlap between C1 and C2 when C1 is voiced

Can the language-related differences in both findings be related to the differences in the realization of voicing and thus in the acoustic properties at the the C1-C2 transition?

## Part 2, “Prosodic” effects. More background

- a) Articulatory strengthening at prosodic boundaries  
(e.g Keating et al. (2003), LabPhon 6; Cho & Keating, UCL WPP 106)

What information on prosodic structure does the speaker make available to the listener?

Most previous work in this paradigm based on simple syllable structures (but see Byrd & Choi, in press, LabPhon 10)

## b) Prosody as a probe

Link to topic 1: How stable is the internal structure of clusters?

Does timing difference between /kl/ and /kn/ remain stable over varying prosodic conditions?

Does e.g /kn/ have less internal cohesion than /kl/?

## Corpus:

3 clusters (/kl/, /kn/, /sk/)

4 boundary conditions

- Utterance initial

- Phrase initial

- List item

- Prosodic word

2 stress conditions

- Initial cluster occurs both in syllables with and without lexical stress

# Test Words

- stressed:

Claudia ['klaʊdiə]

Kneipe ['kneɪpə]

Scarlett ['ska:lət]

- unstressed:

Klausur [klaʊ'zʊə]

Kneipier [kneɪ'pje:]

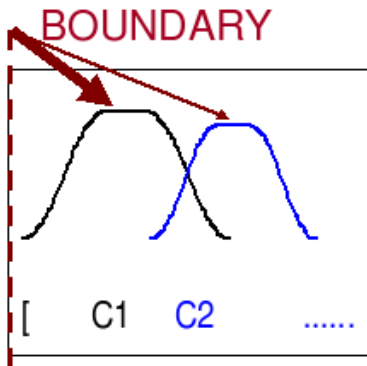
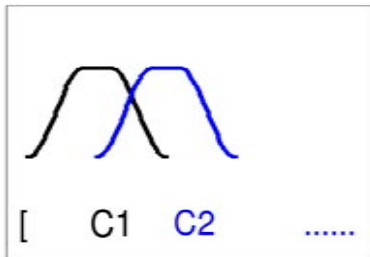
Skandal [skan'da:l]

- U** Thomas studiert in Fulda. **Claudia** geht noch zur Schule.  
*(Thomas goes to college in Fulda. Claudia is still in school.)*
- P** Olga sagt immer, **Claudia** sei zu jung. *(Olga always says that Claudia is too young.)*
- L** Thomas, Peter, **Claudia** und Elke fahren in den Süden.  
*(Thomas, Peter, Claudia and Elke are travelling south.)*
- W** Gestern war **Claudia** noch gesund. *(Yesterday, Claudia was still well.)*

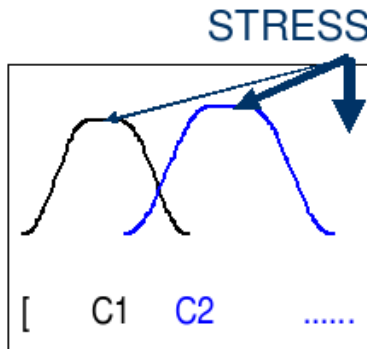


# Hypotheses

## “Neutral” cluster



- ▶  $\pi$ -gesture (Byrd and Saltzman 2003)
- ▶ origin at the boundary
- ▶ diminishing with distance from boundary, stronger on C1
- ▶ less overlap at strong boundaries



- ▶ origin at syllable nucleus
- ▶ diminishing with distance from the nucleus, stronger on C2
- ▶ less overlap in stressed syllables

## **Method**

EMA, 3 subjects (as in Part 1)

Additionally, respiratory activity monitored by respiratory inductive plethysmography (Respirace)

# Prosodic grouping

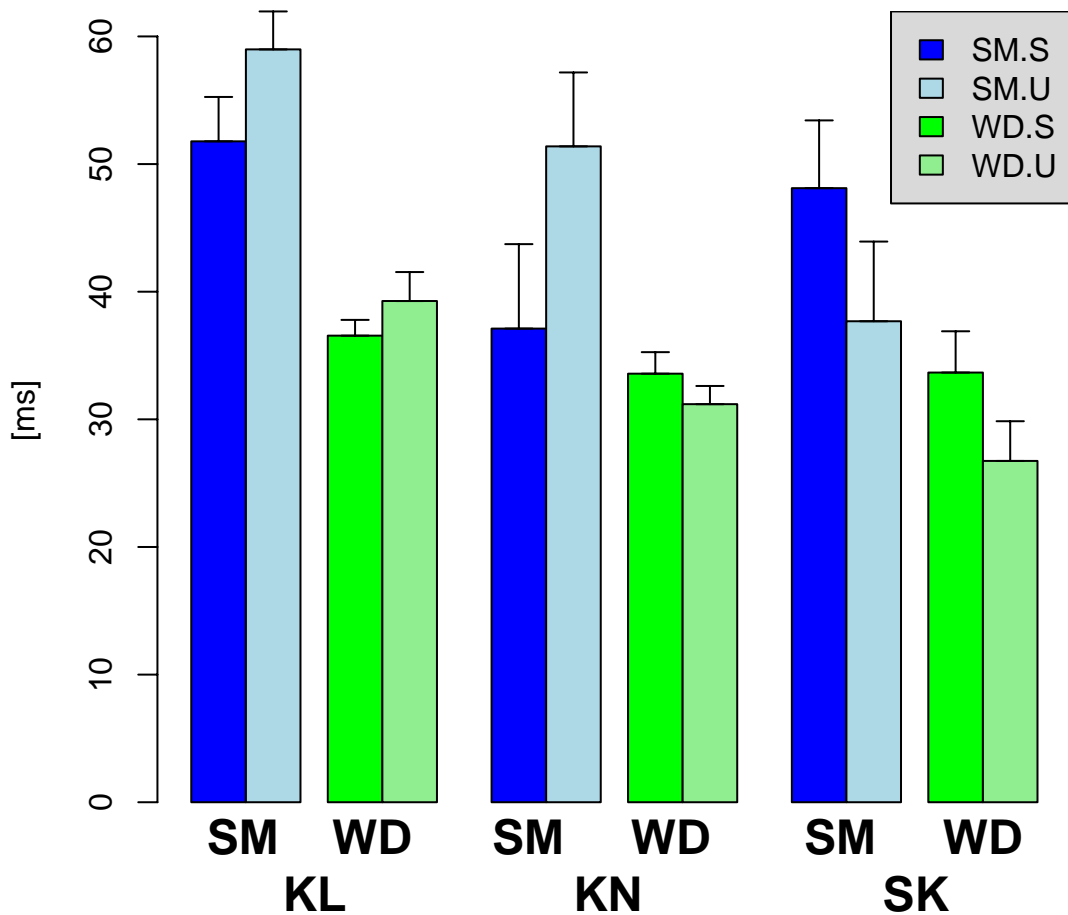
- 3 prosodic categories (Cho and McQueen 2005)
  - BG: Big Boundary (pause and boundary tone)
  - SM: Small Boundary (no pause but boundary tone)
  - WD: Prosodic Word (no pause, no boundary tone)

## Mapping of syntactic definitions to prosodic groups

	Small boundary SM	Prosodic Word WD
<b>Utterance</b>	51	8
<b>Phrase</b>	28	62
<b>List</b>	14	76
<b>Word</b>	2	89

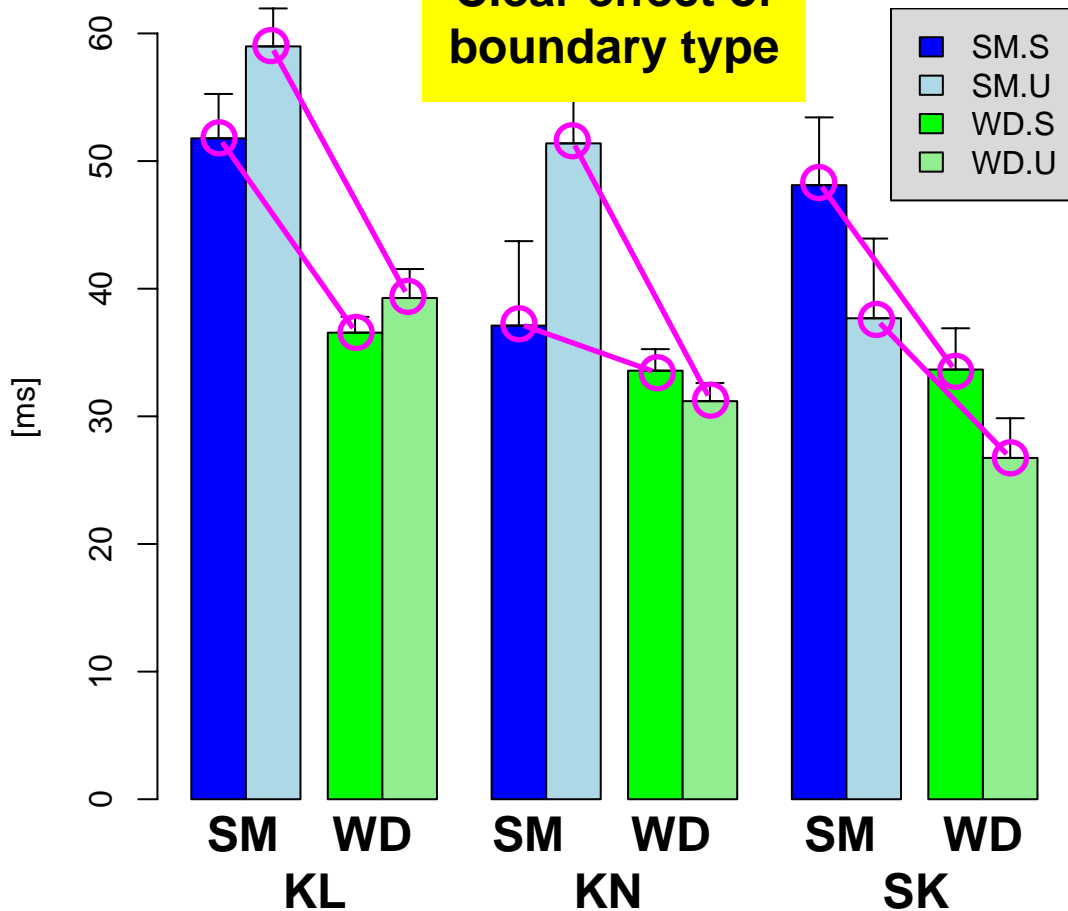
Hardly any Big Boundaries occurred in this corpus, so not used in further analyses

# C1 duration, Subj. IK



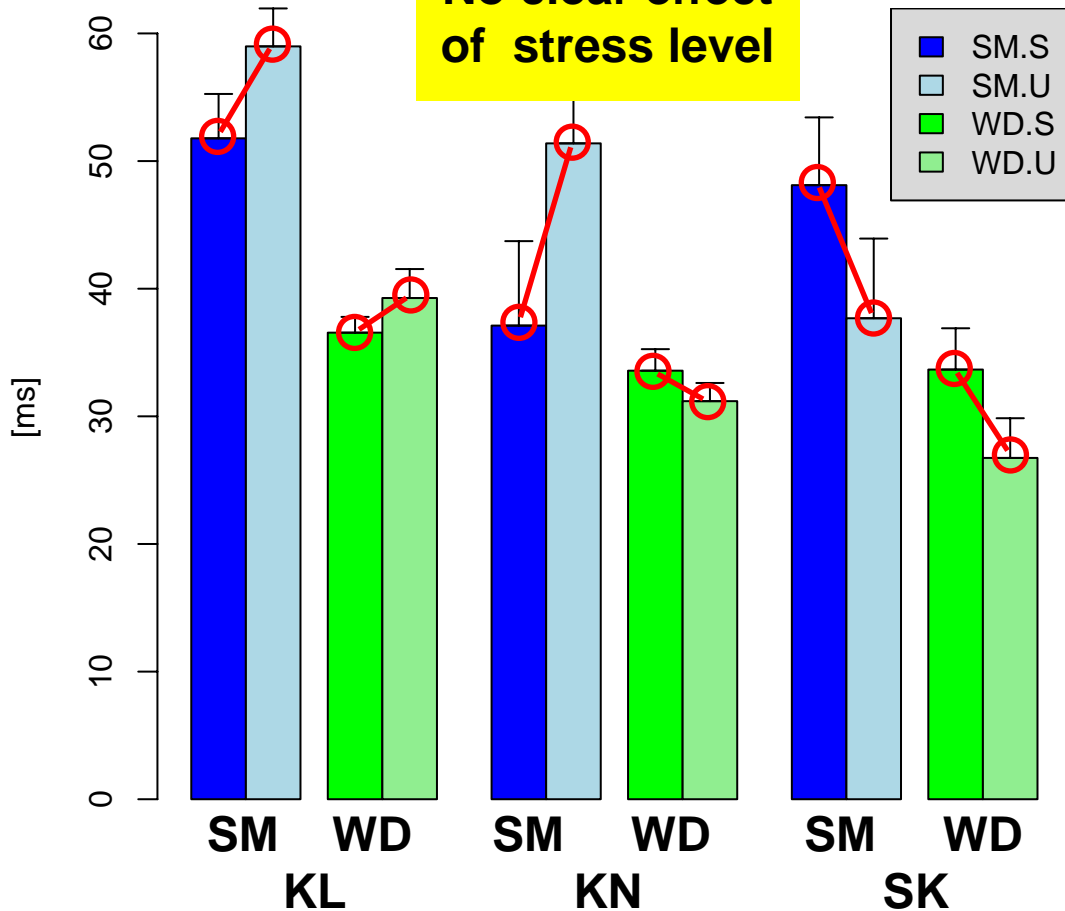
# C1 duration, Subj. IK

Clear effect of boundary type

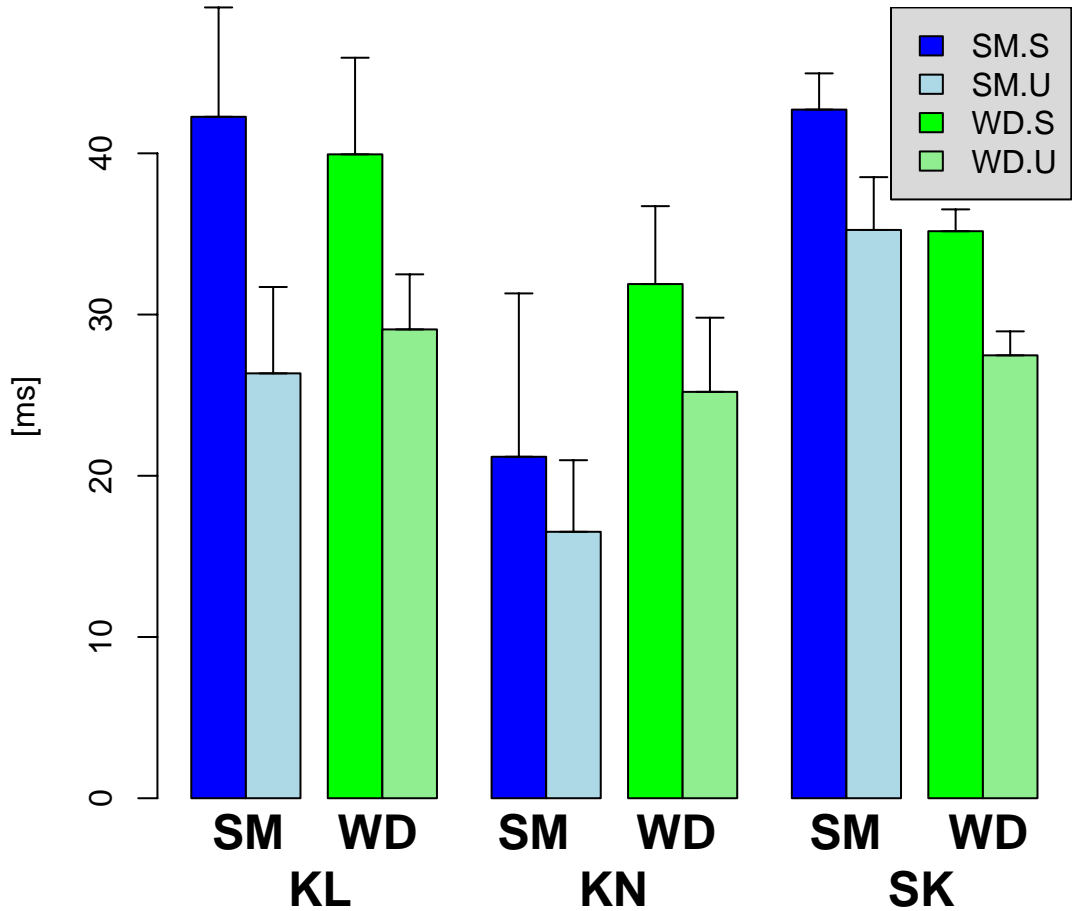


# C1 duration, Subj. IK

**No clear effect  
of stress level**



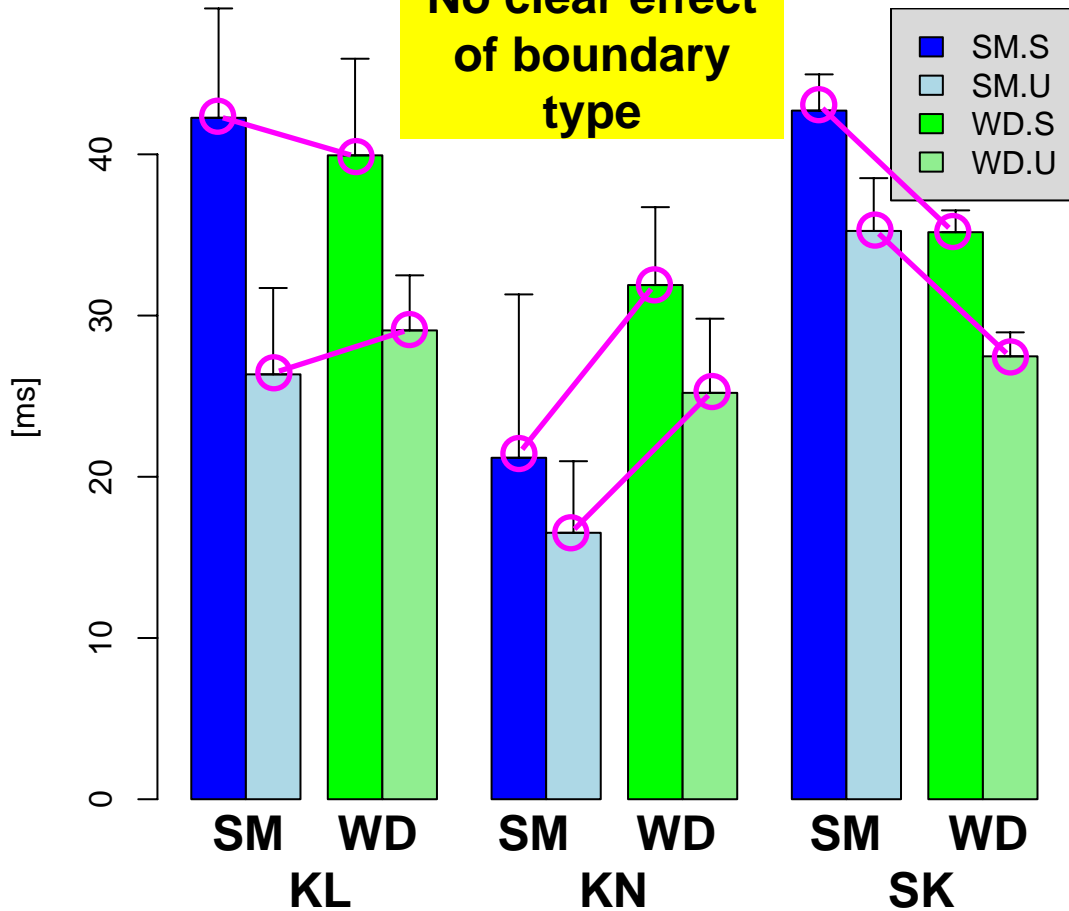
# C2 duration, Subj. IK





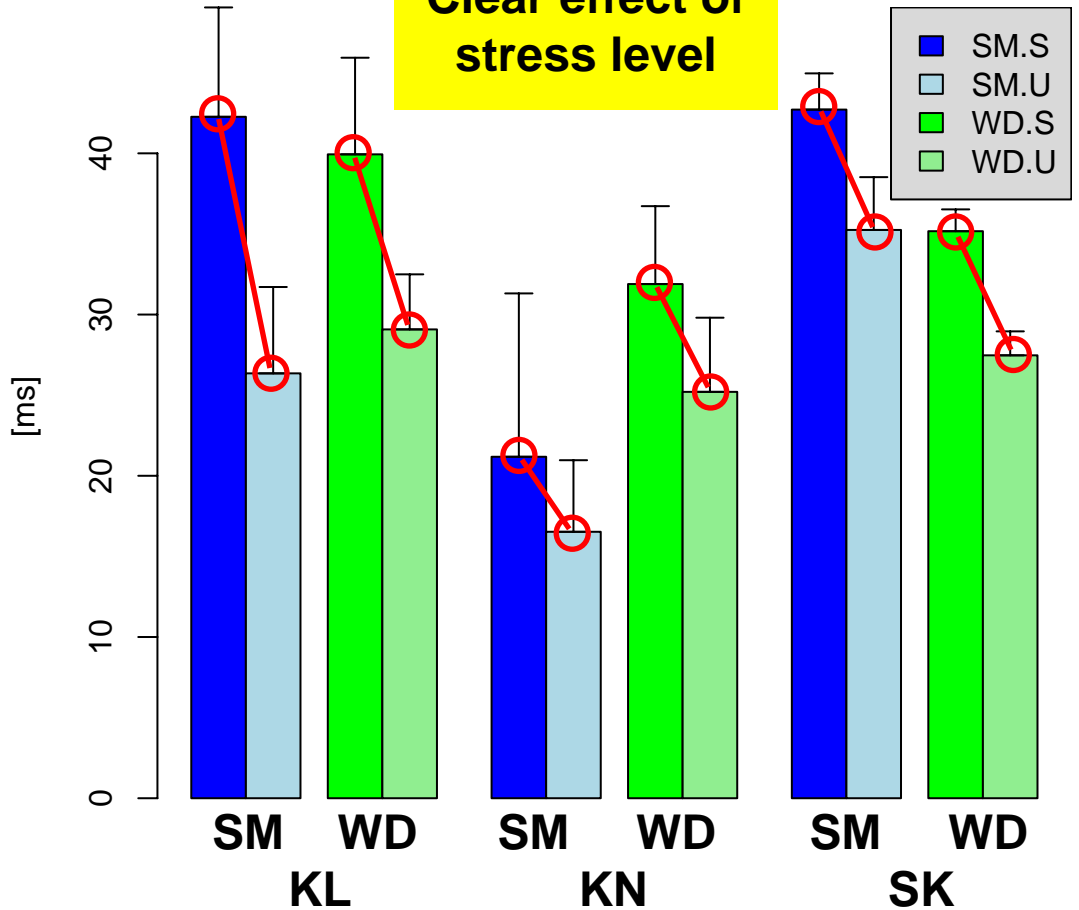
# C2 duration, Subj. IK

No clear effect  
of boundary  
type

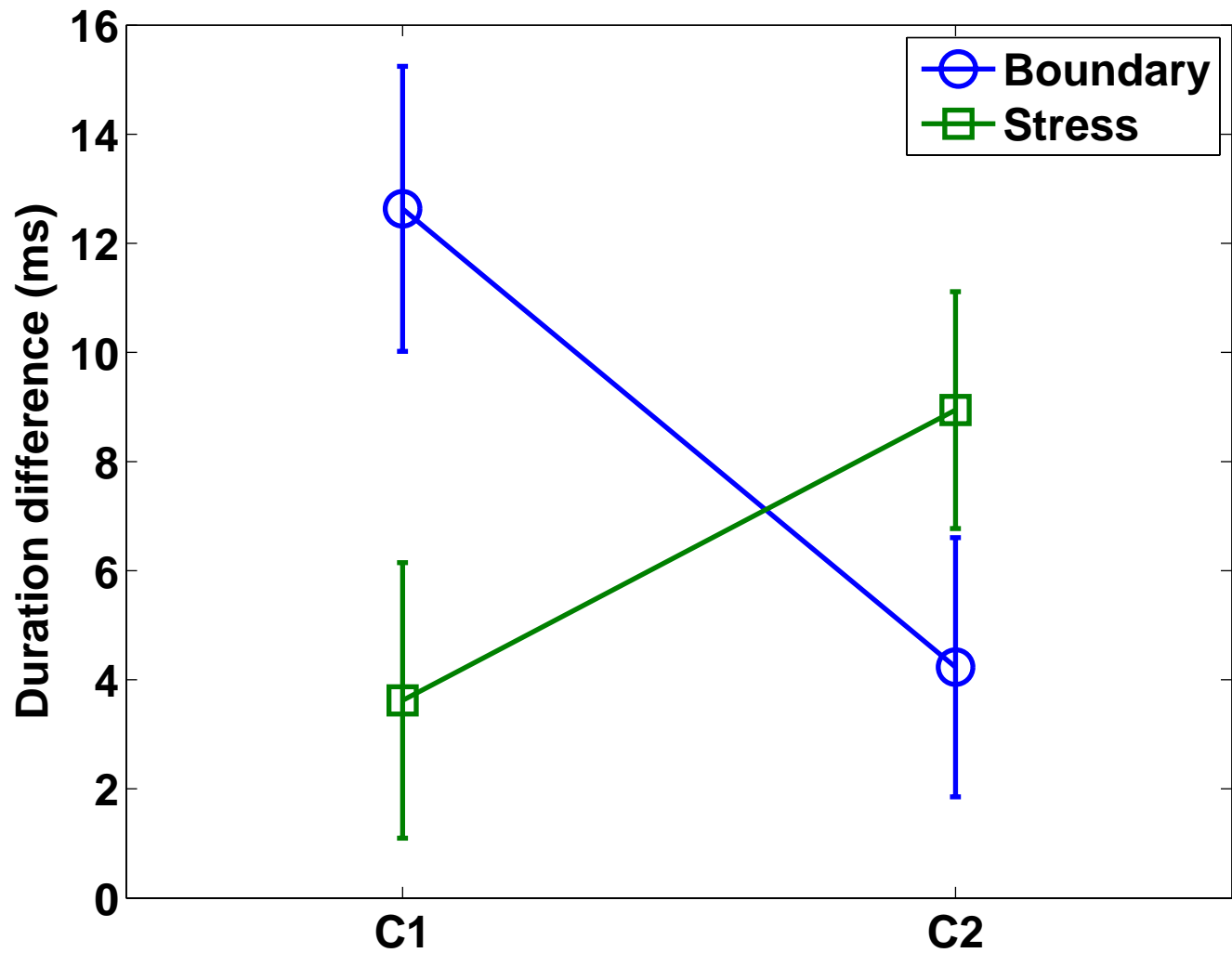


# C2 duration, Subj. IK

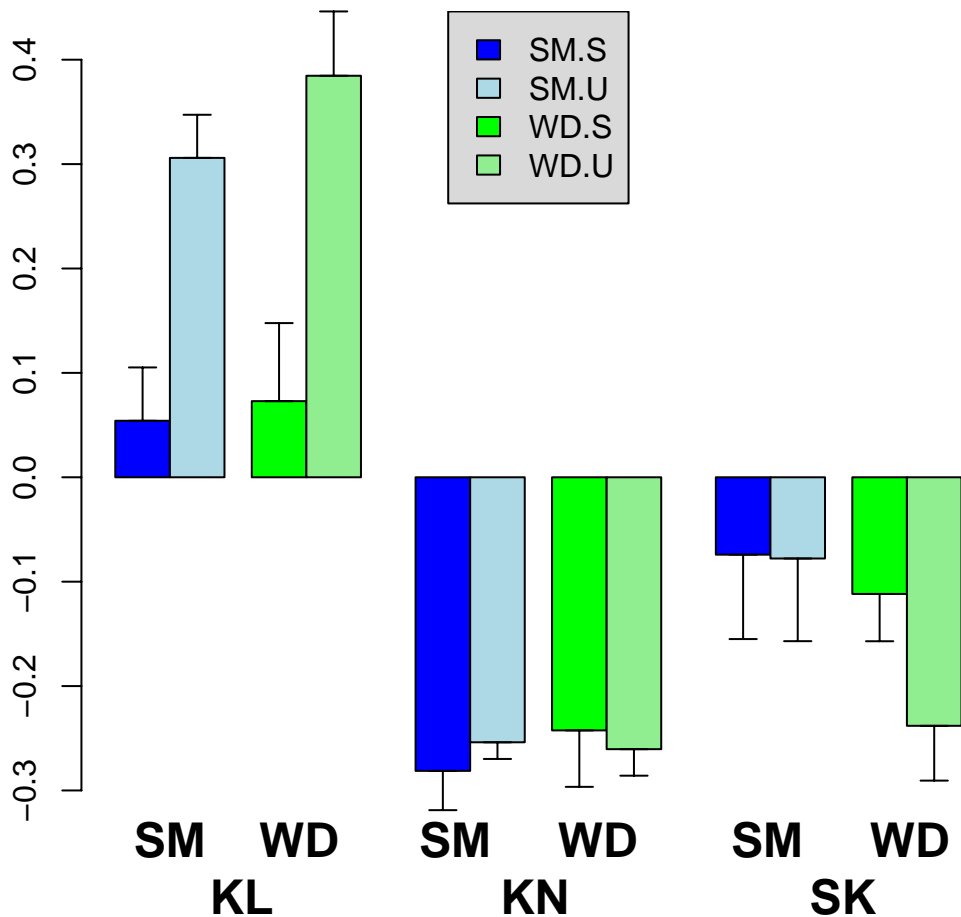
**Clear effect of stress level**



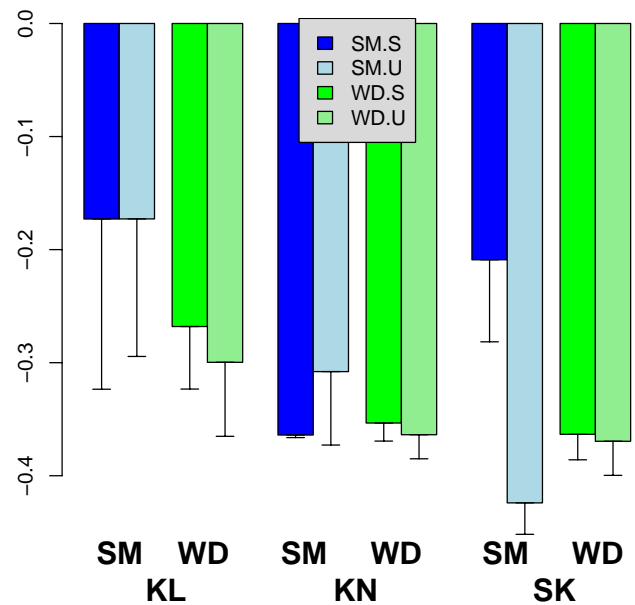
Mean pairwise duration differences (n=18)



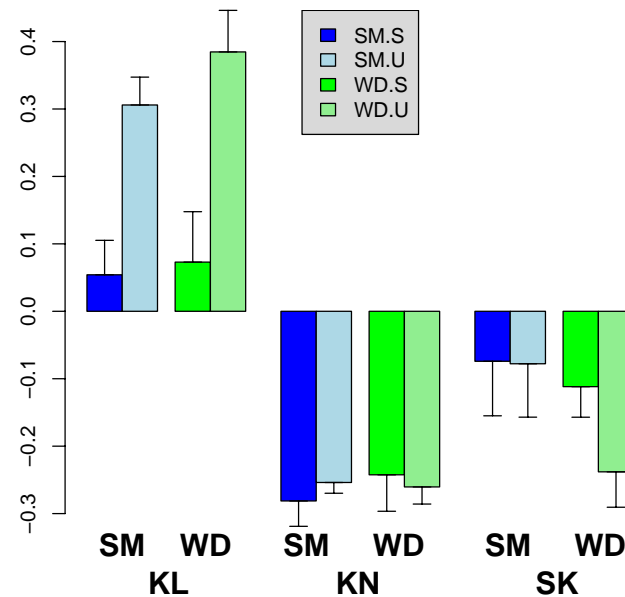
# Relative Overlap, Subj. IK



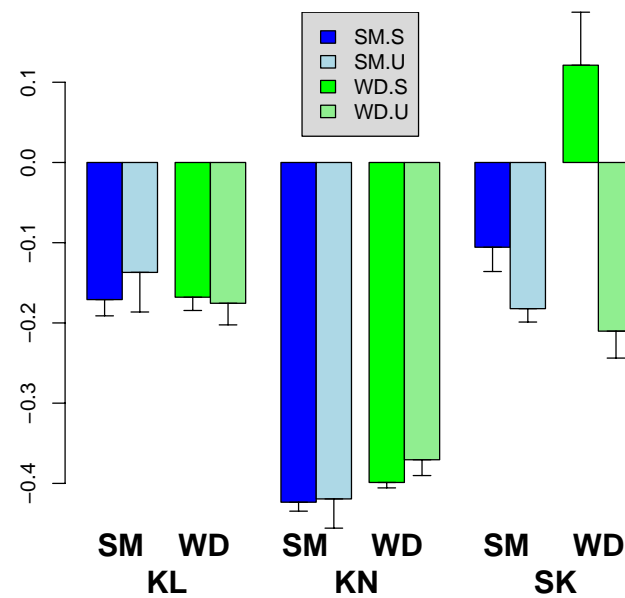
Relative Overlap, Subj. MM



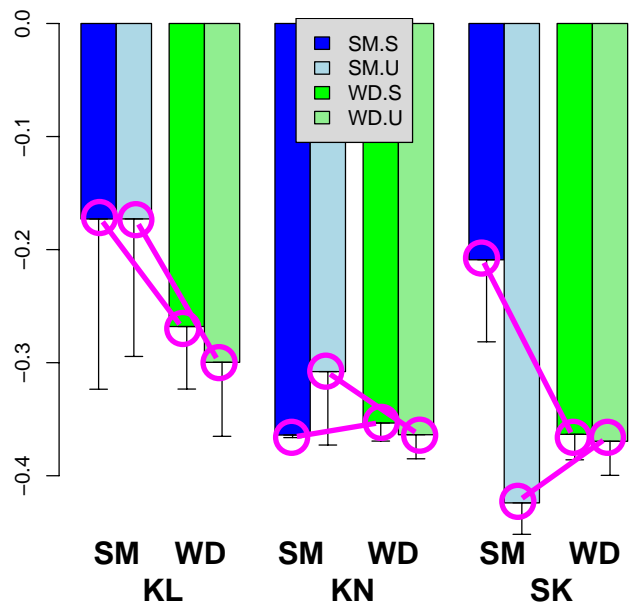
Relative Overlap, Subj. IK



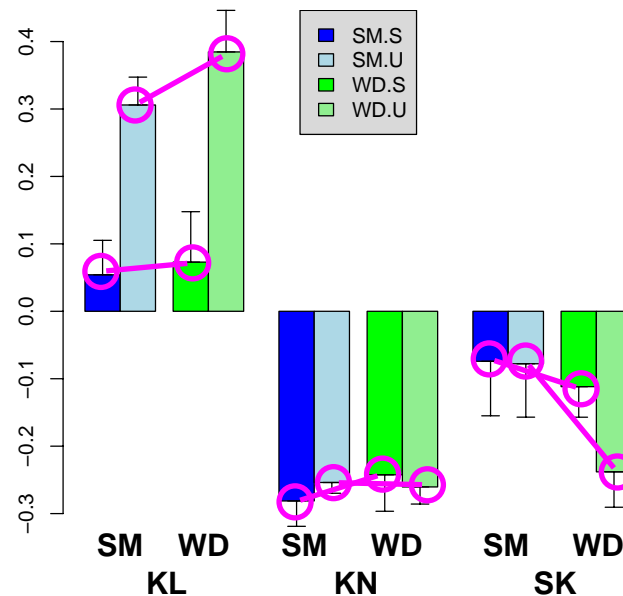
Relative Overlap, Subj. MO



Relative Overlap, Subj. MM

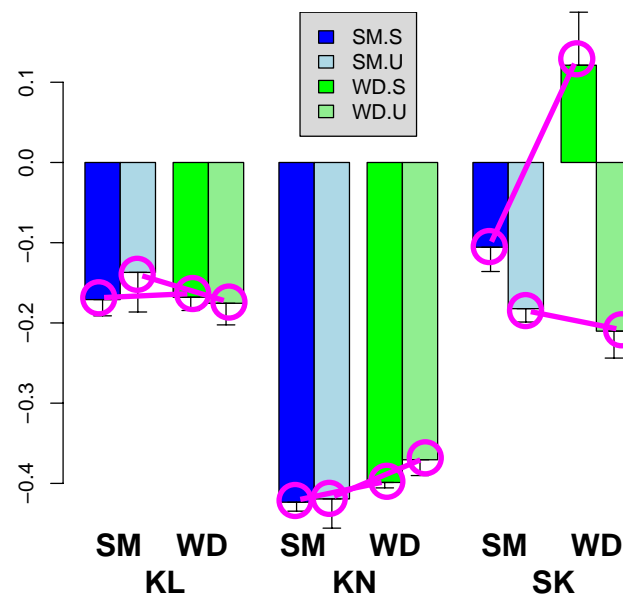


Relative Overlap, Subj. IK

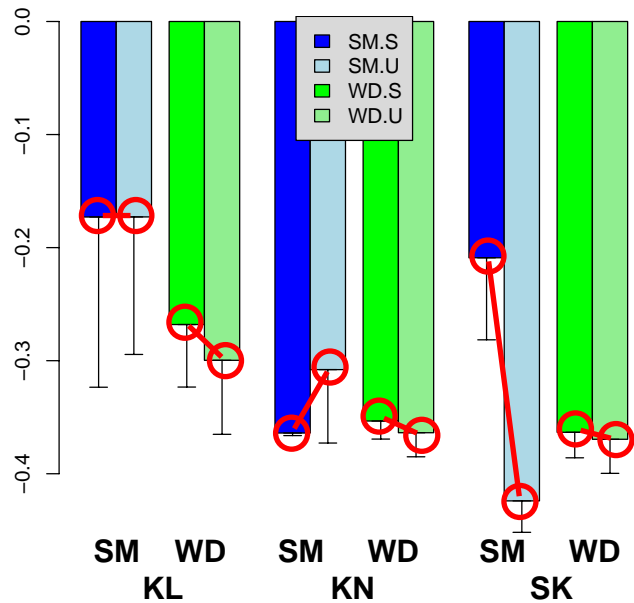


**No clear effect of boundary type**

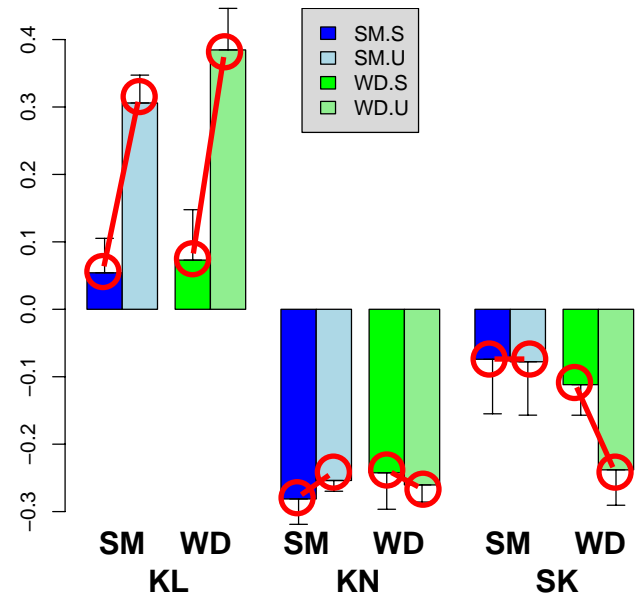
Relative Overlap, Subj. MO



Relative Overlap, Subj. MM

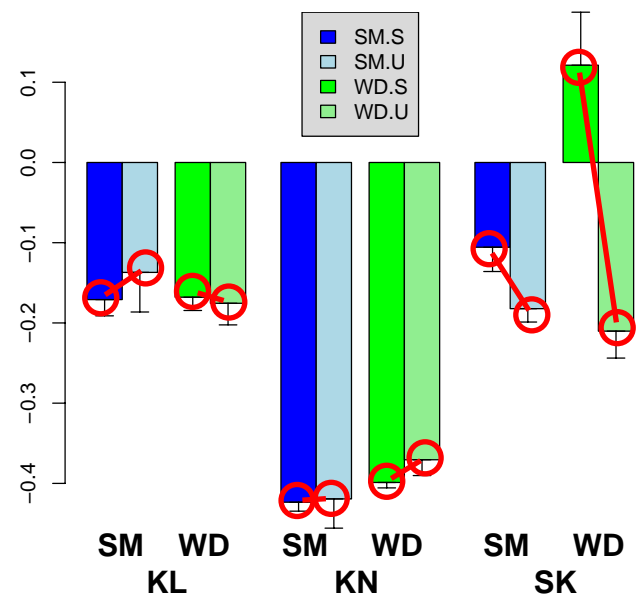


Relative Overlap, Subj. IK

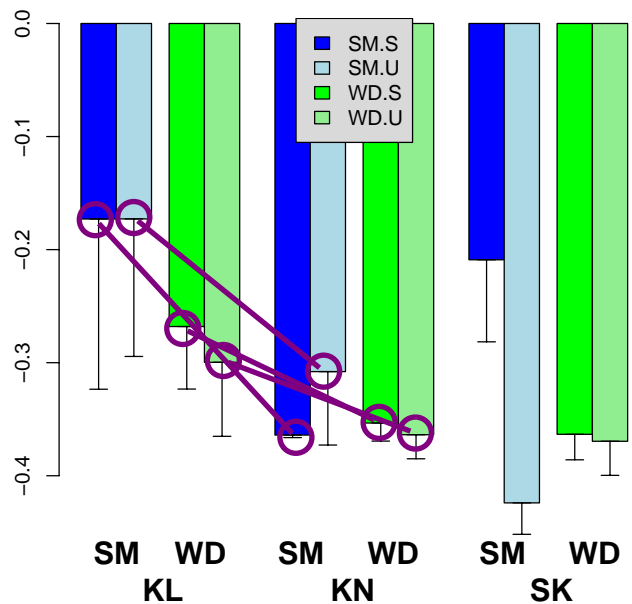


**No clear effect of stress level**

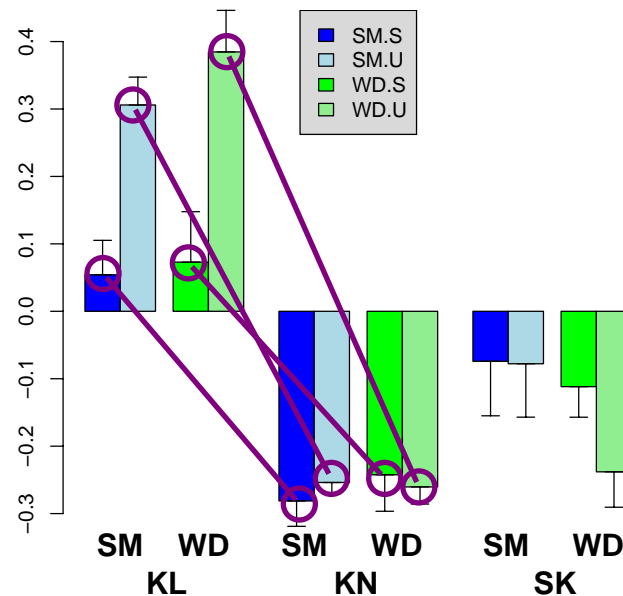
Relative Overlap, Subj. MO



Relative Overlap, Subj. MM

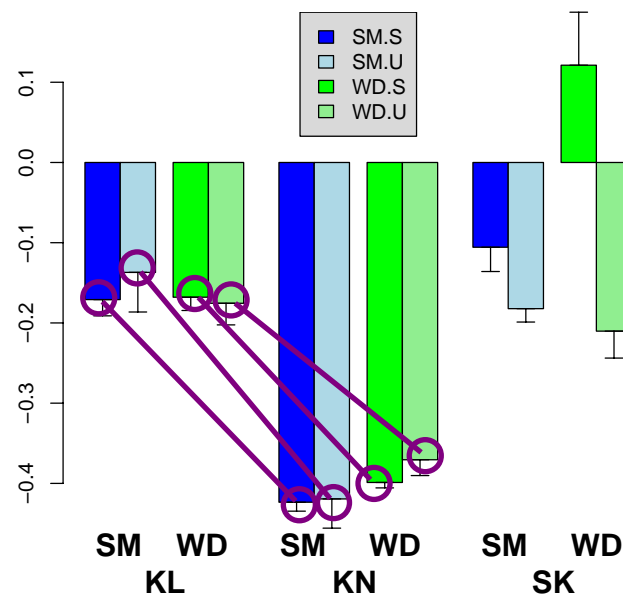


Relative Overlap, Subj. IK



**Huge effect of C2 in  
kl vs. kn clusters!  
  
(As in first corpus)**

Relative Overlap, Subj. MO





“Prosody as probe” (previous slide)

No evidence that difference in overlap for /kl/ vs. /kn/ varies strongly over prosodic condition

No evidence that overlap pattern for e.g /kn/ is more strongly affected by prosodic condition than other clusters

## **Summary of main prosodic effects:**

### Expected:

Quite consistent durational effects on C1 (boundary) and C2 (stress)

### Unexpected:

No consistent changes in overlap over prosodic conditions

Not clear whether this overall pattern of results is consistent with a model of boundary effects as local clock slowing; cf. pi-gesture approach of Byrd/Saltzman

## Overall Conclusions

Very robust segmental differences in articulatory coordination

====> Coordination relations form part of the phonological specification of words?

Prosodic effects on coordination comparatively subtle

====> More dependent on how speakers interpret the communicative demands of a specific utterance?

Further confirmation of the stability of syllable-initial position.

## Outlook

Towards a more stringent explanation for difference in timing patterns of plosive+lateral vs. plosive+nasal

====> articulatory synthesis