Organization of /sC-/ and /Cs-/ Onsets in Romanian

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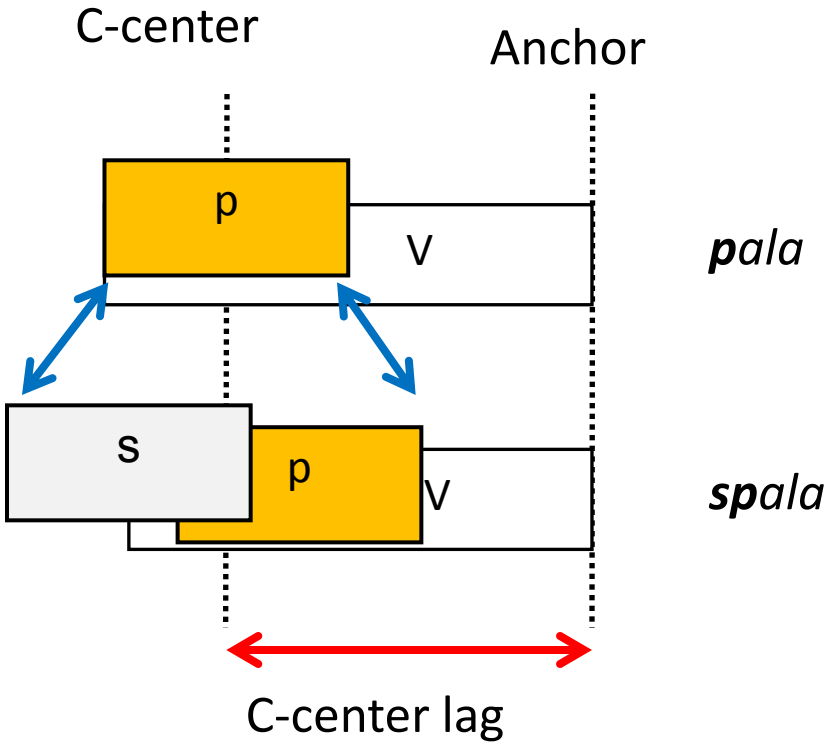
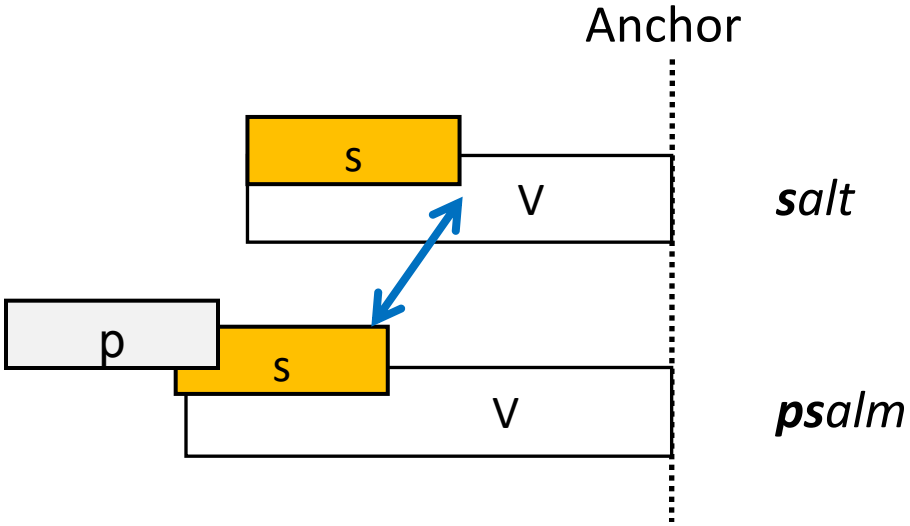
Background

- Order of consonants in cluster plays a role in the temporal organization of onsets in relation to the following vowel
- Romanian sC onsets (SP-, SK-, SM-) C-center organized



- Romanian Cs onsets (PS-, KS-)



Prevocalic consonant shifted away from the vowel in stop-series

→ vowel lengthening

→ slowing down in production of the cluster words compared to the singleton words

Current Study

- Are there order effects affecting the temporal relation of the two consonants in sC vs. Cs onset clusters?

  Chitoran et al. 2002: front-to-back /bg-/ more overlapped than back-to-front /gb-/; labio-coronal/coronal-labial less overlapped than other place combinations

  Bombien, 2011: /kl-/ more overlapped than /kn-/

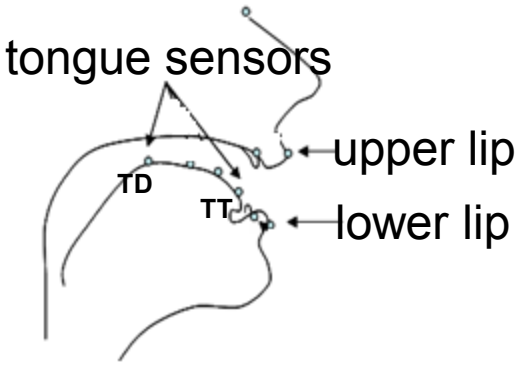
- If so, are such effects due (in part) to requirements on perceptual recoverability?

Production Experiment: Materials and Method

Stimuli (produced by 5 native Romanians):
sC: SP-, SK- (/'spalə/, /'skalə/)
Cs: PS-, KS- (/'psalm/, /kseno'fob/)

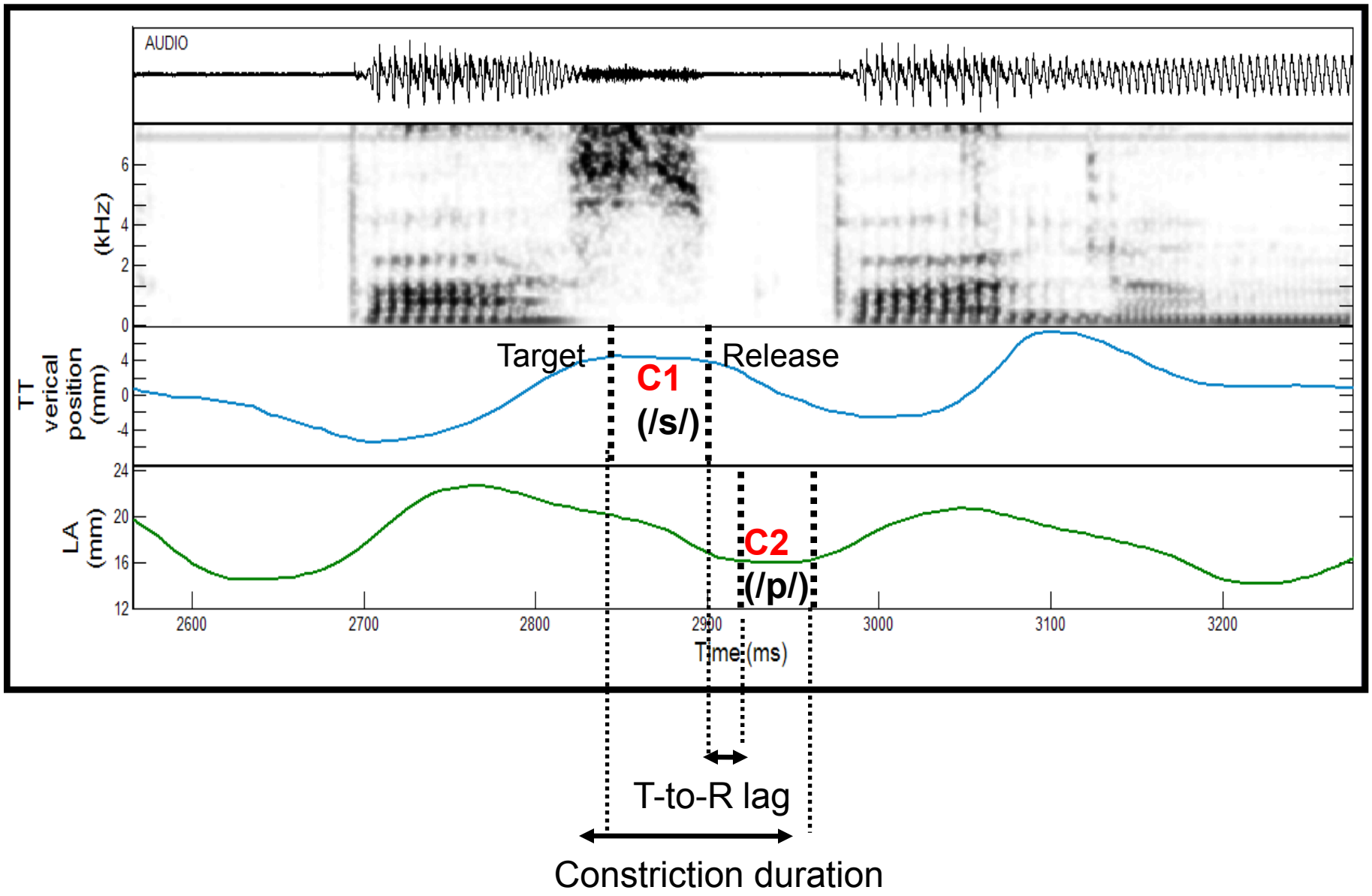
EMA Recordings

(AG500, Carstens Medizinelektronik)

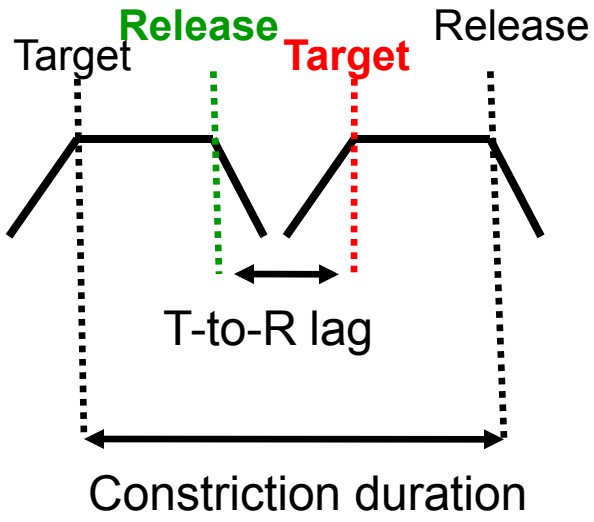


[p] – Lip Aperture
[s] – Tongue Tip vertical movement
[k] – Tongue Dorsum vertical movement

Example: /**sp**alə/



Target-to-release lag analysis



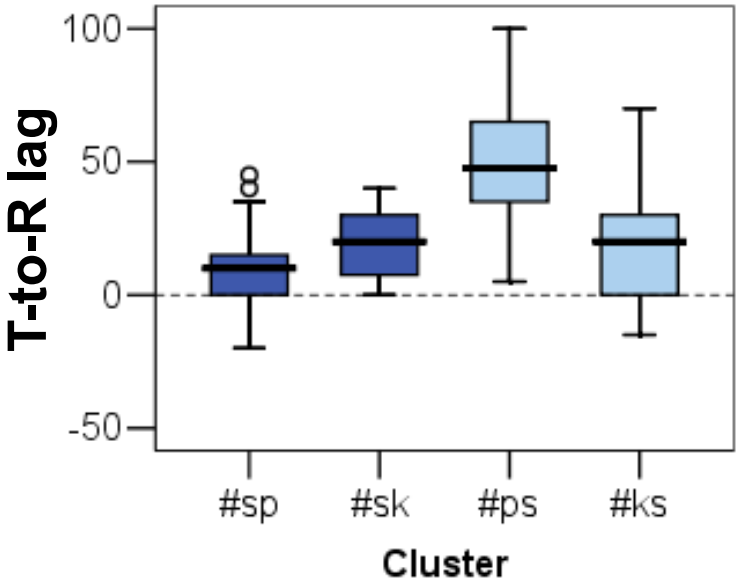
Target-to-release lag = Target_C2 – Release C1

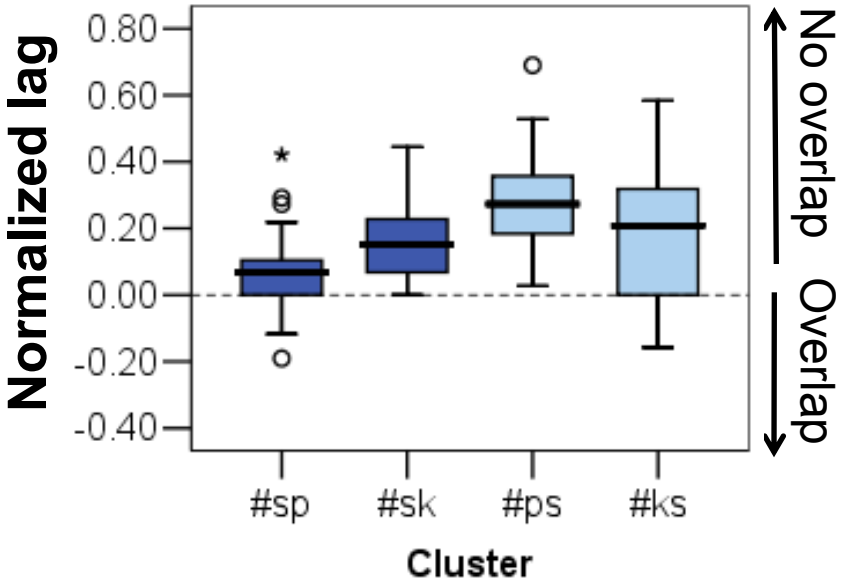
Negative values indicate that the release of C1 is overlapped by C2

Positive values indicate C2 achieves its target after C1 release

Normalized lag = Target-to-release lag/Constriction duration

Results





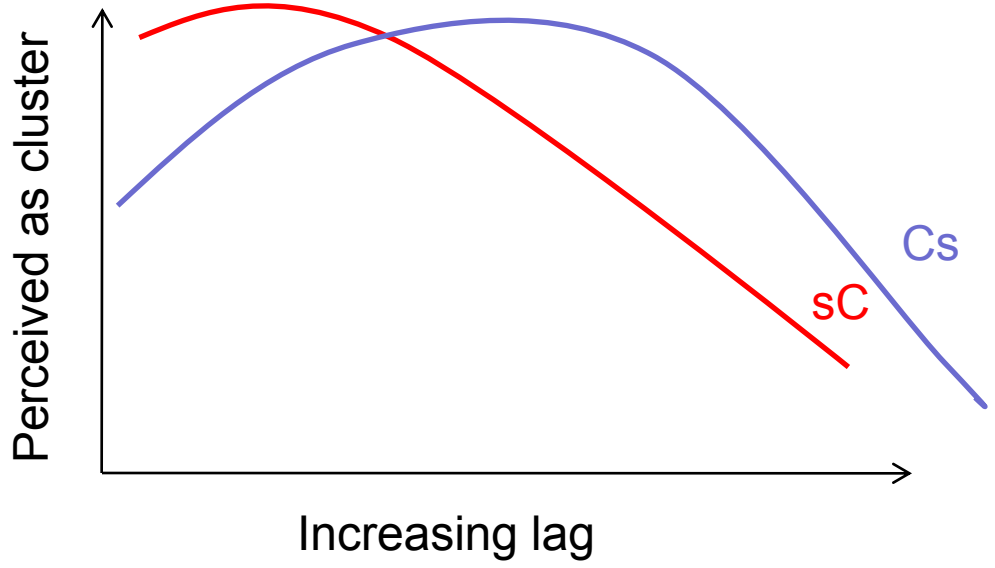
- sC-clusters have smaller lags than Cs (SP- vs. SK- n.s.)
- Order effect significant for SP- vs. PS- (not for SK- vs. KS-, but KS- more variable)
  - Less lag for front-to-back clusters? No
  - More lag for labio-coronal/coronal-labial clusters? Yes for PS-, no for SP-

→ More lag for Cs- than sC- onsets to ensure perception of stop released into sibilant?

Perception Experiment

- Is more lag needed to perceive a Cs- than an sC- cluster?

- Is more lag permitted for Cs than sC before perception of cluster degrades?



Materials

Stimuli (produced using the articulatory synthesizer TADA):

CC	CVC
sC: spad, skad	**səC** (V ~40ms, ~20ms, ~10ms): səpad, səkad
Cs: psad, ksad	**CəS**: pəsad, kəsad

(cvc40, cvc20, cvc10)

• Cluster base stimulus – default TADA implementation for onset clusters

• Continuum: C2 started (and ended) +2/+4 frames later than preceding stimulus (1 frame ~ 10ms)

e.g. spad, spad2, spad4, spad8, spad12, spad16, spad20, spad24

(cc, cc2, cc4…)

cc12: C2-formation starts 1 frame after C1-release ends

cc24: C2-formation starts 13 frames after C1-release ends

Method

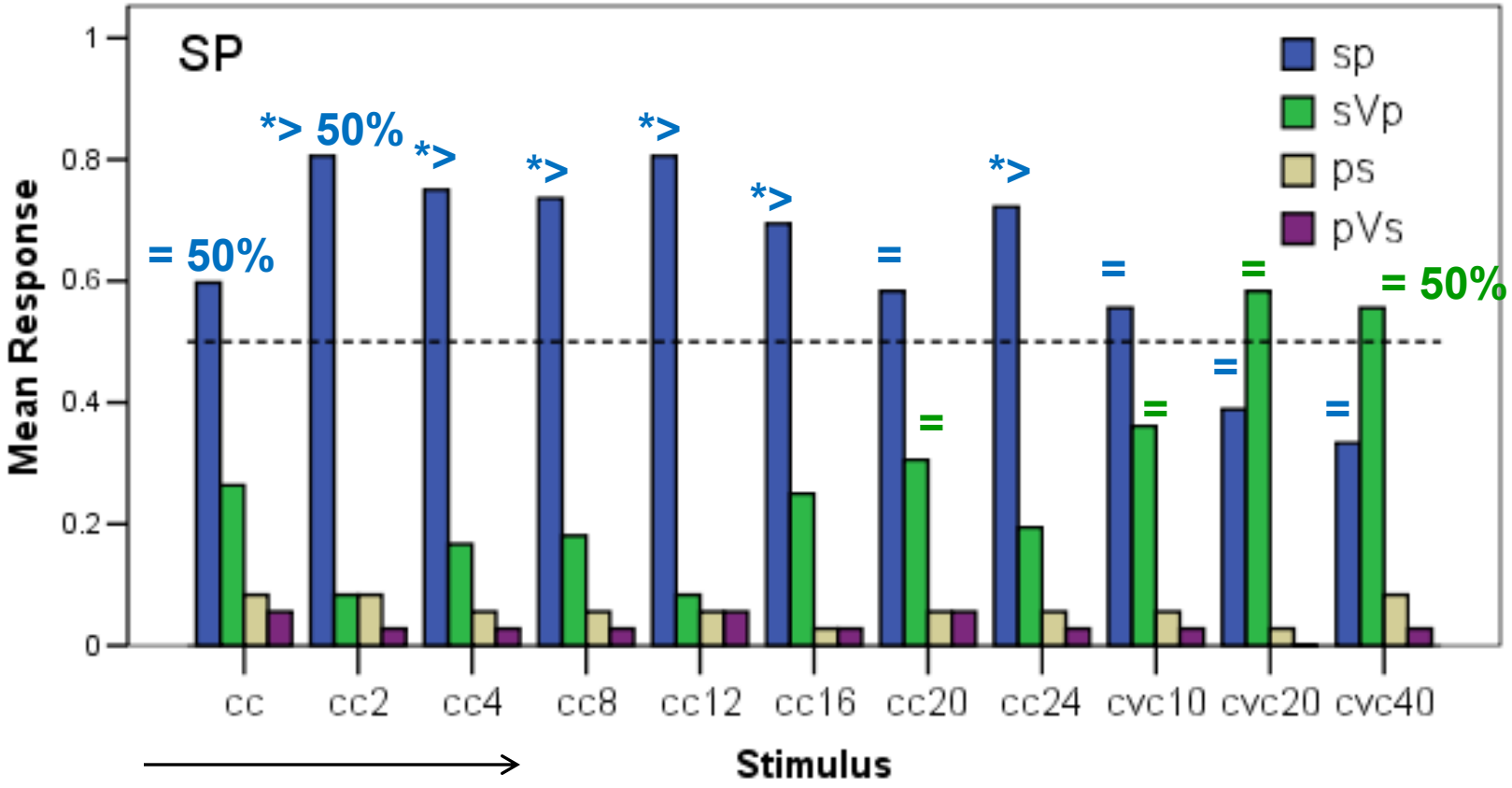
13 listeners (Romanian native speakers)

DMDX presentation

- Forced choice (separately for sp/ps, sk/ks, each stimulus heard 3 times): sp, ps, sVp, pVs/ sk, ks, sVk, kVs
- AXB (always presented last, each stimulus heard twice):
  A/B: CC and CVC
  X: CC, CC2, CC4… CC24, CVC

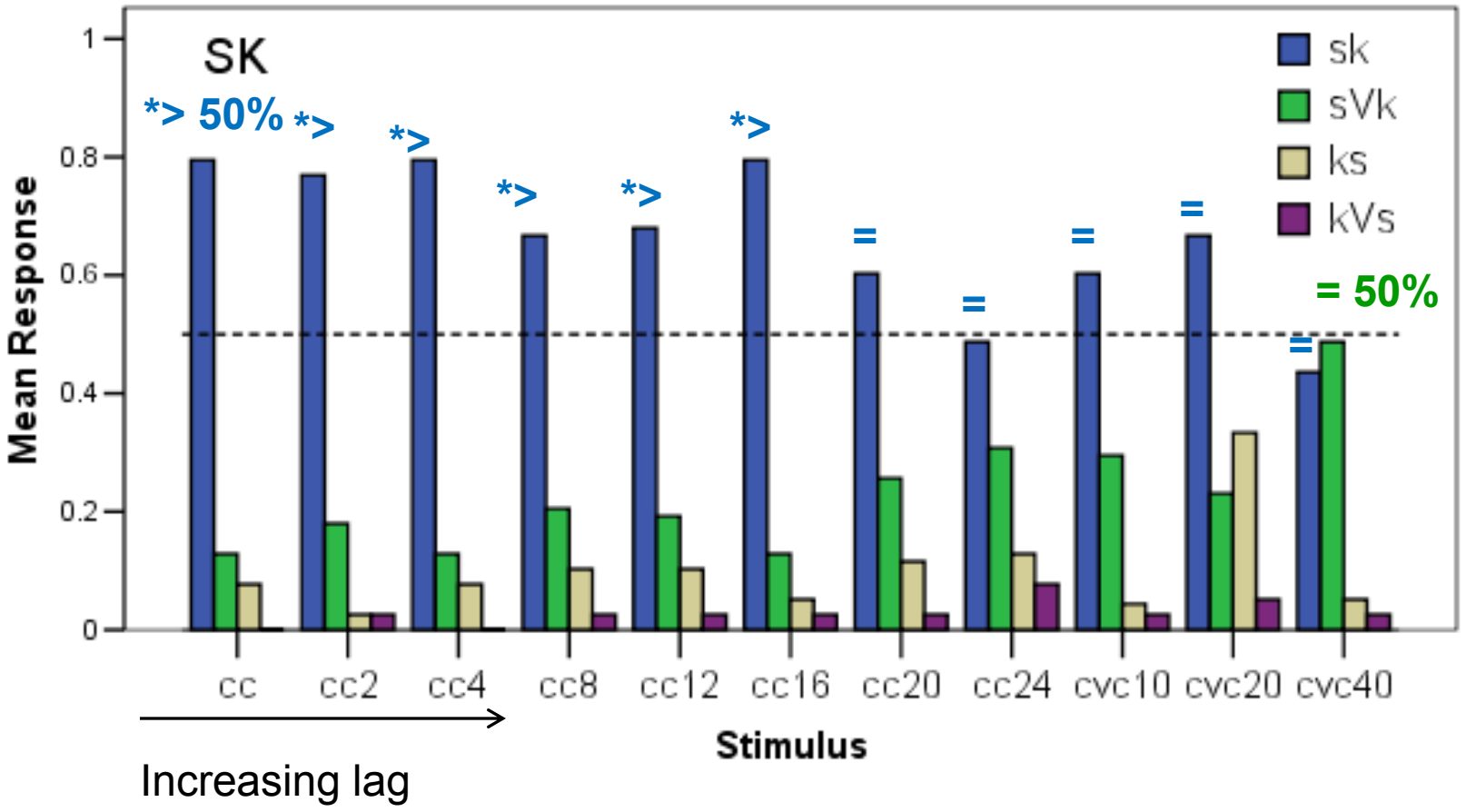
Choice presented orthographically

Results forced choice

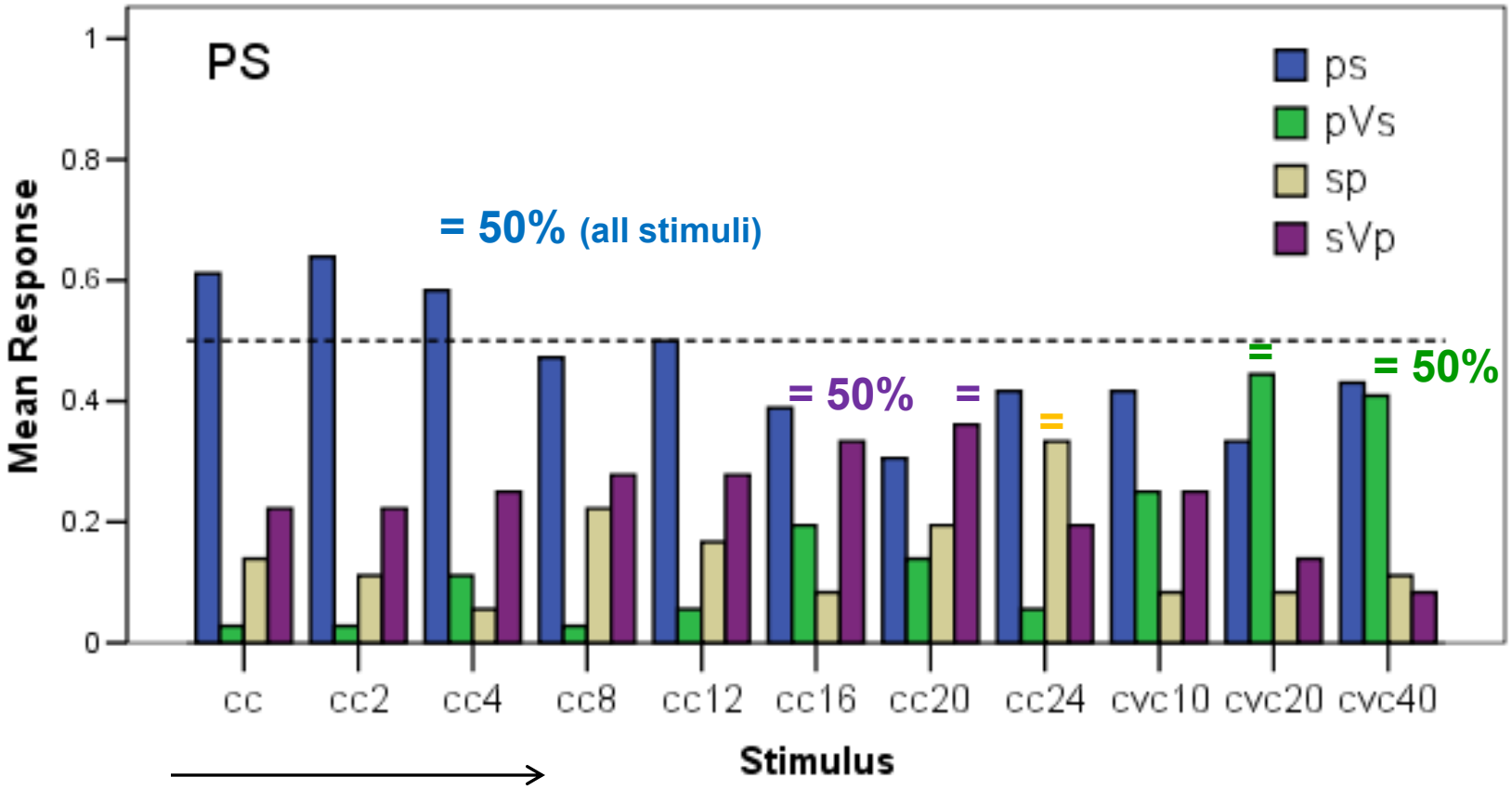


Increasing lag

Results forced choice

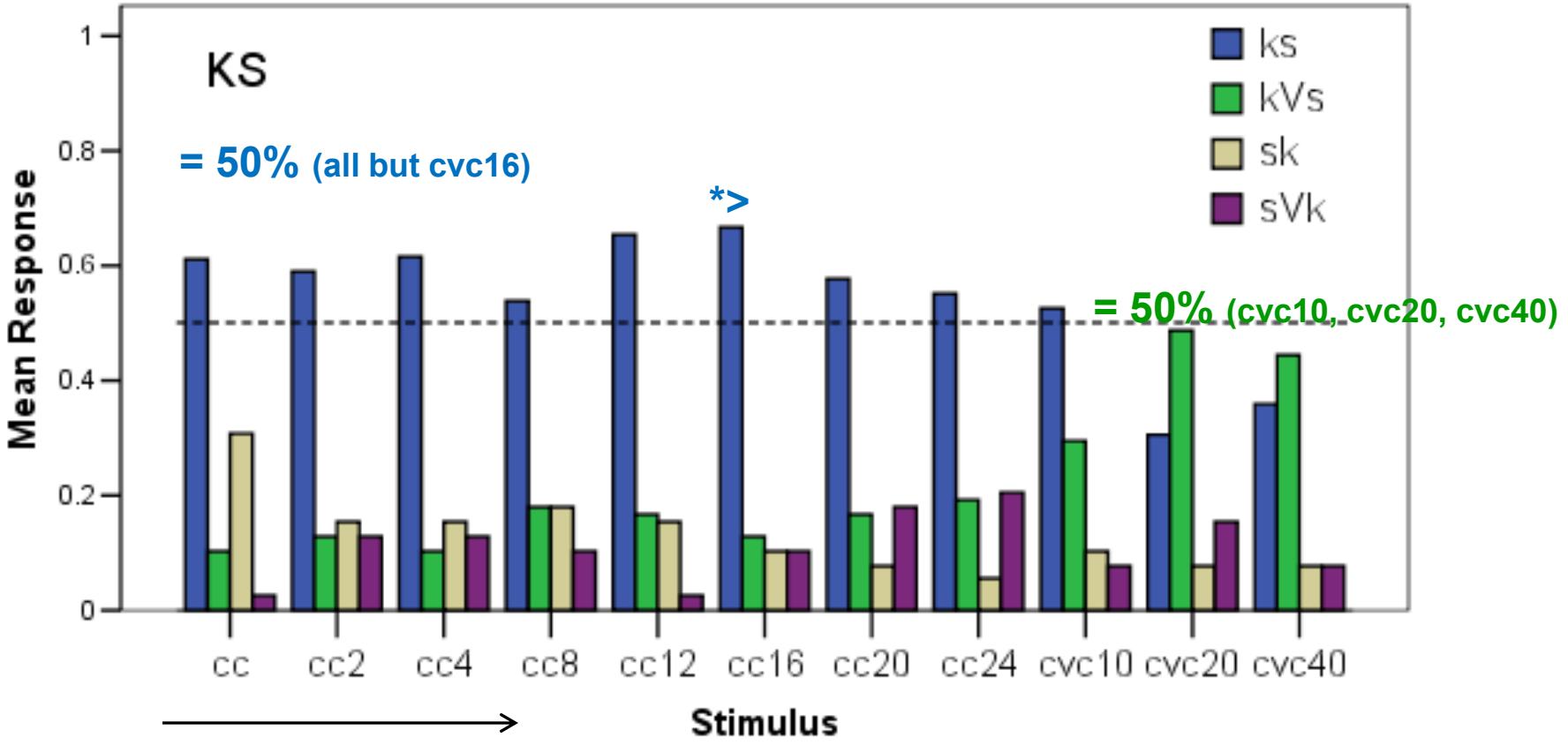


Results forced choice



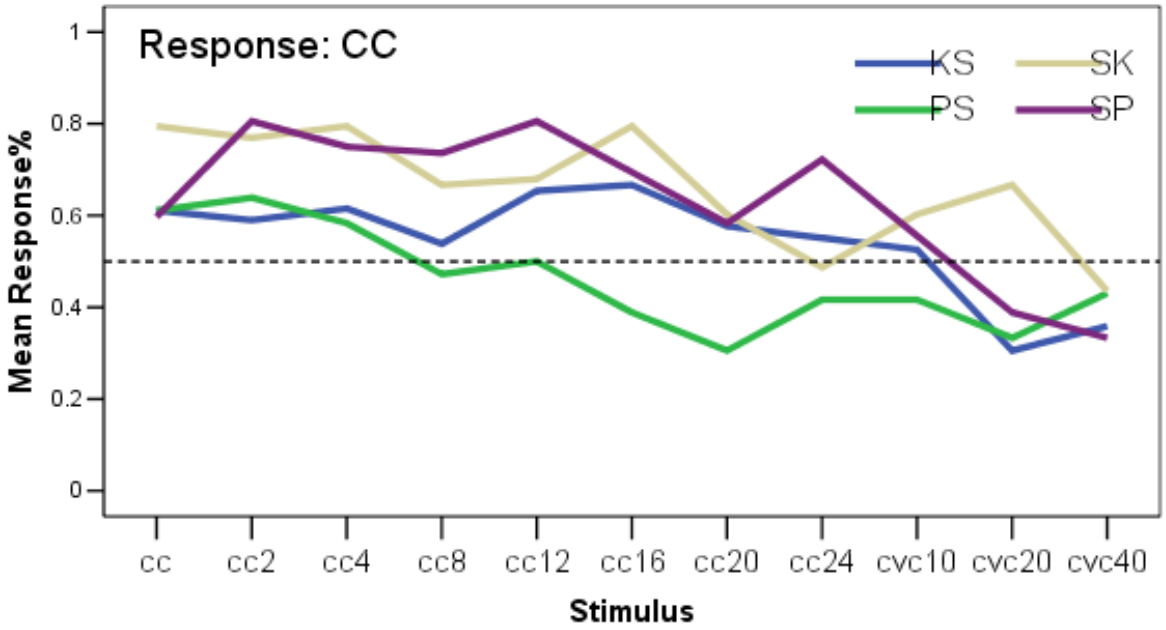
Increasing lag

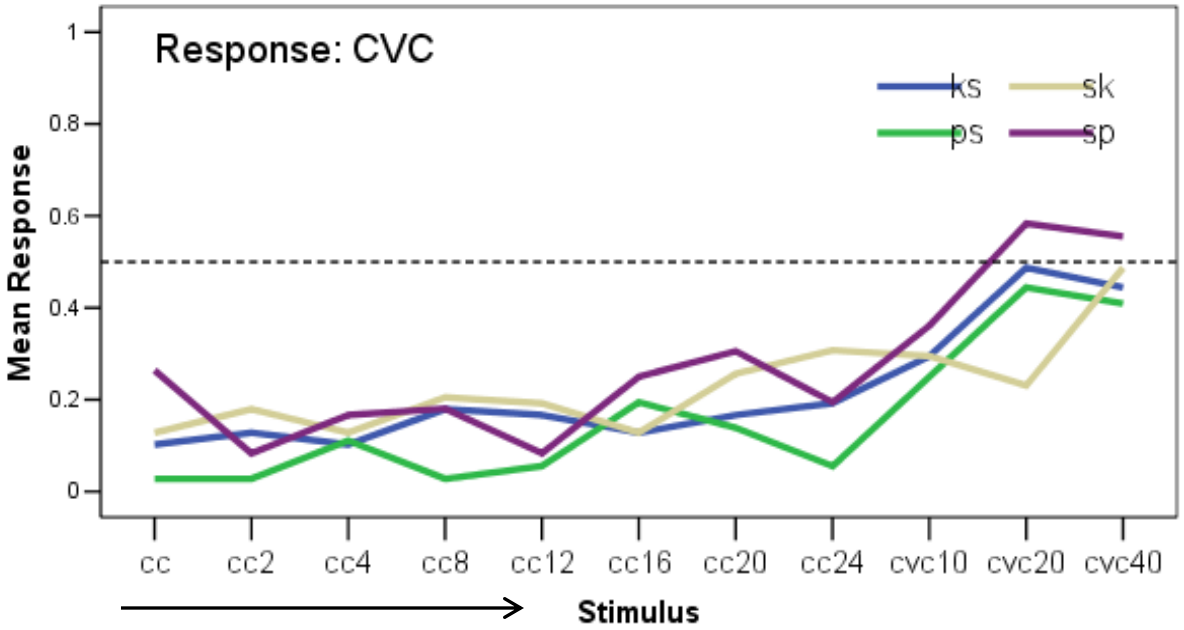
Results forced choice



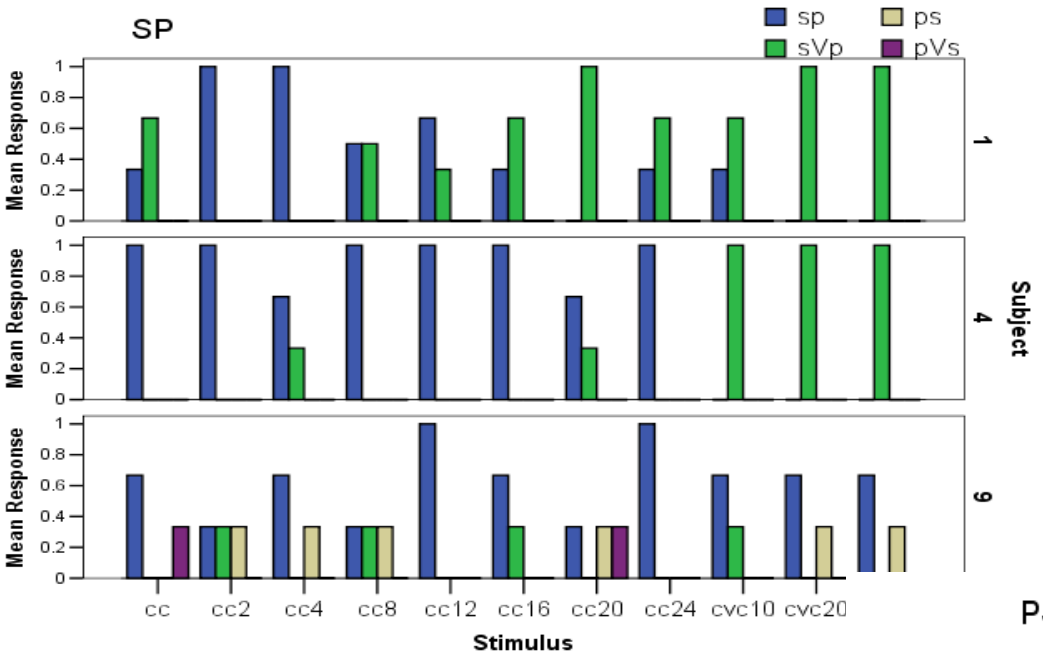
Increasing lag

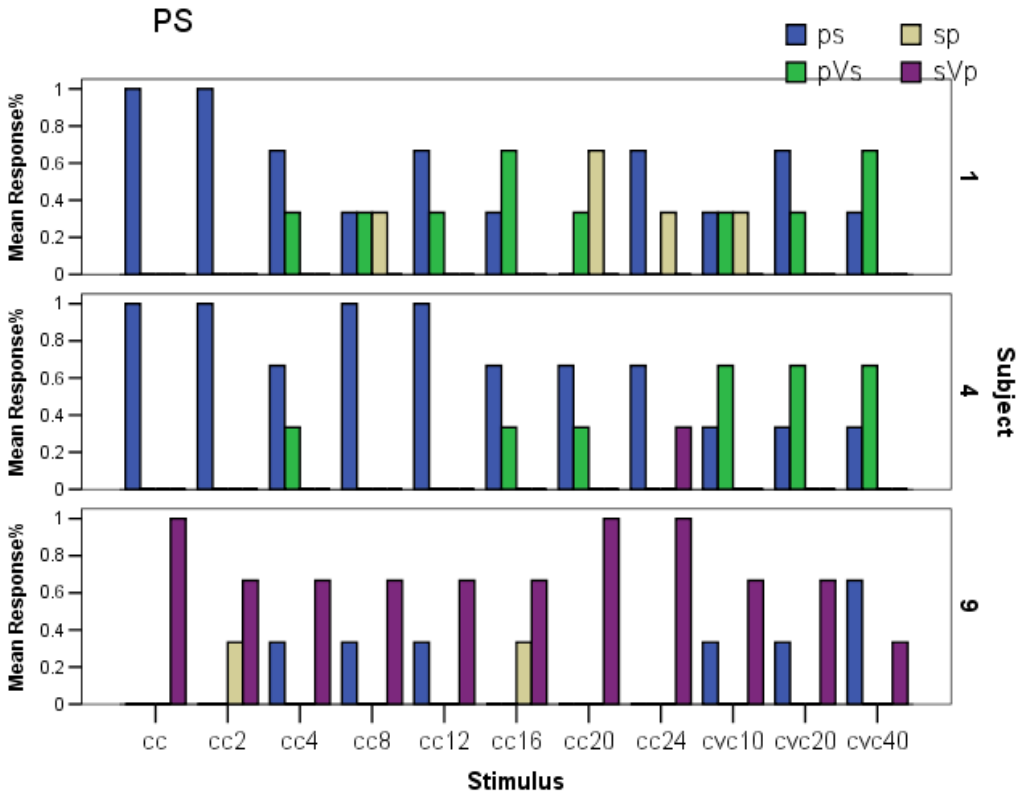
Results forced choice

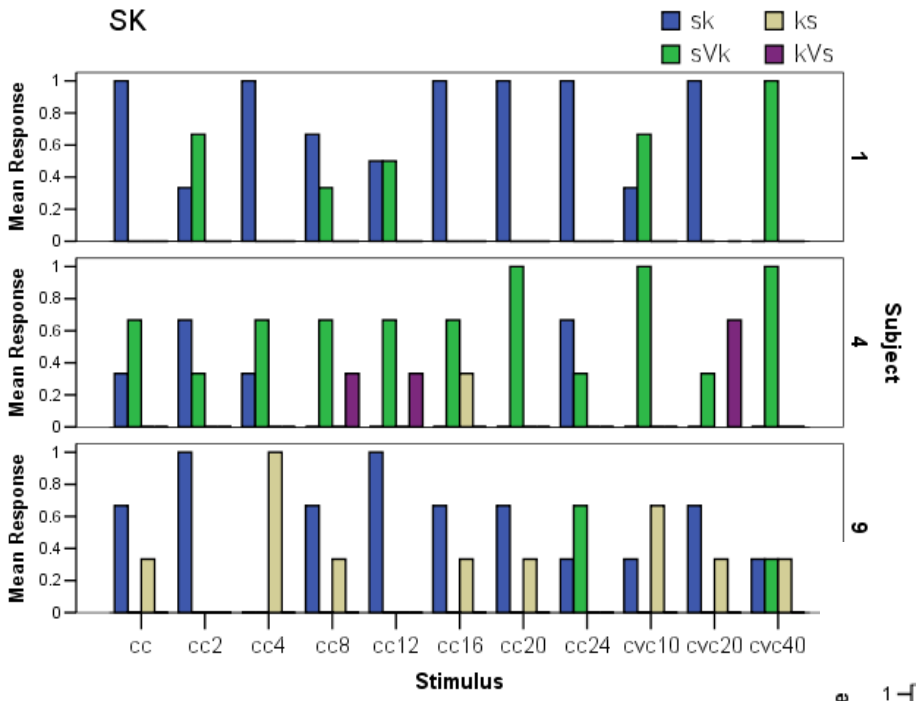




Increasing lag


SP
sp
ps
sVp
pVs
Mean Response
1
4
9
Subject
cc
cc2
cc4
cc8
cc12
cc16
cc20
cc24
cvc10
cvc20
Stimulus


PS
ps
sp
pVs
sVp
Mean Response%
1
4
9
Subject
cc
cc2
cc4
cc8
cc12
cc16
cc20
cc24
cvc10
cvc20
cvc40
Stimulus


SK
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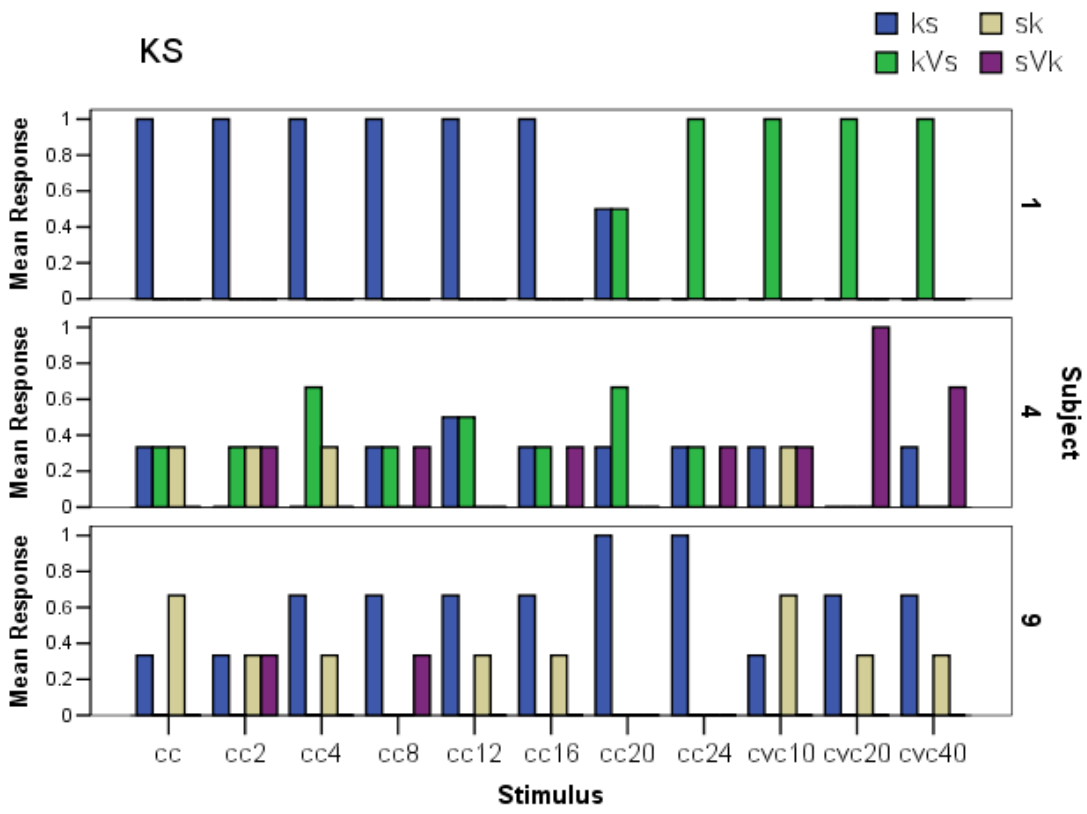
cvc40
Stimulus


KS
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Mean Response
Subject
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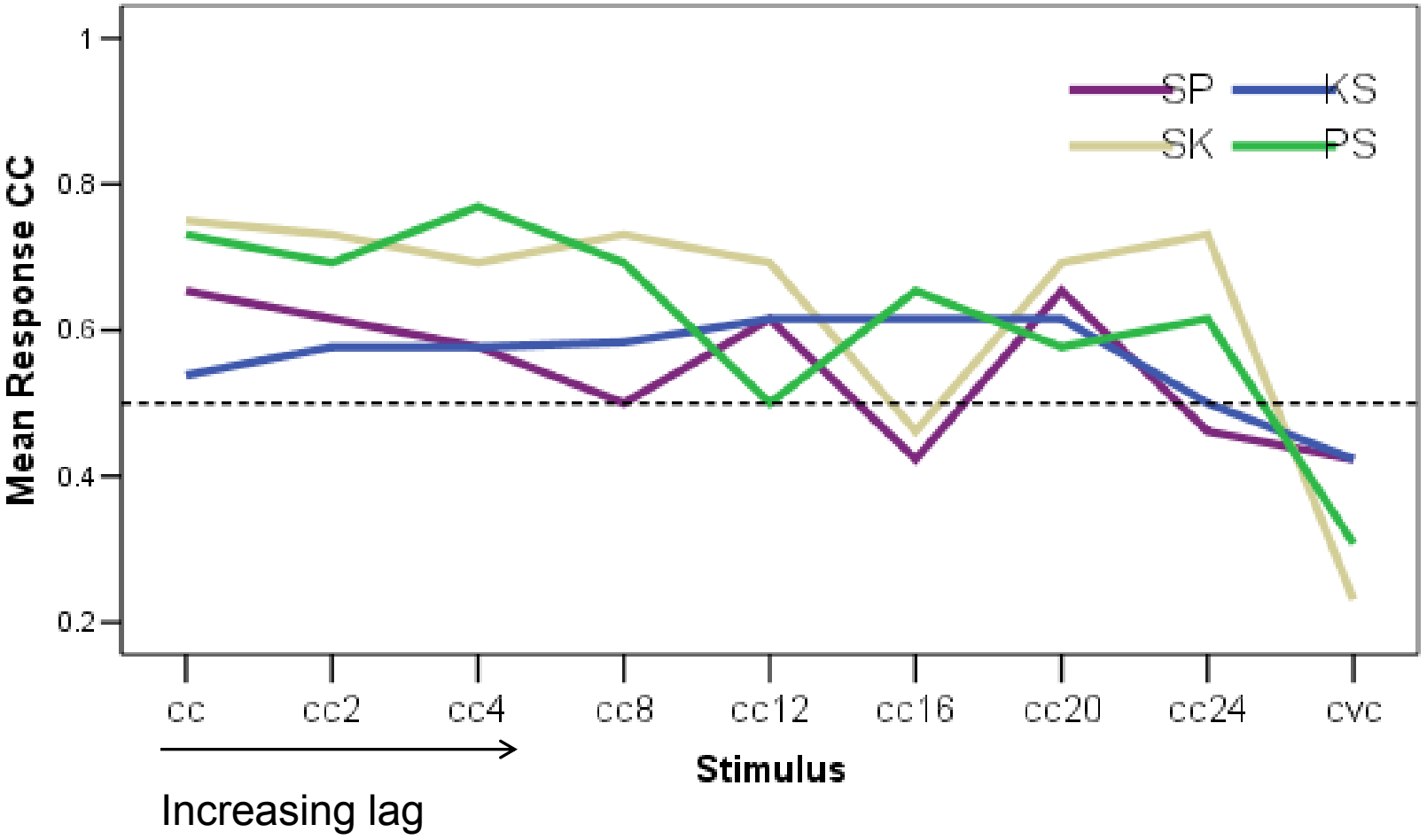
cvc10
cvc20
cvc40
Stimulus

Results AXB



SP, KS continua: not different from chance
SK: CC, CC2, CC4, CC8, CC20, CC24 *> 50%; CVC *< 50%
PS: CC, CC2, CC4, CC8 *> 50%; CVC *< 50%

Discussion

- Is more lag needed to perceive a Cs than an sC cluster?
  - No – if anything, increased lag for /ps/ clusters leads to degradation of cluster percept

- Increased lag observed in production of Cs- may not be guided by perception requirements:

  -Larger lag in Cs- may be caused by the same mechanism that caused a shift away from the vowel (and vowel lengthening) → slowing down of production system

- Independent of lag manipulation, perception of Cs- cluster is overall less accurate than that of sC- clusters

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