

The enhancement effects of background knowledge on selective auditory attention: an analysis of cortical responses in the cocktail party problem

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Mechanisms of Attention: Human Studies II**

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Speech stream segregation

Overlapping auditory objects is challenging to hear
as one mixture maps to several sources

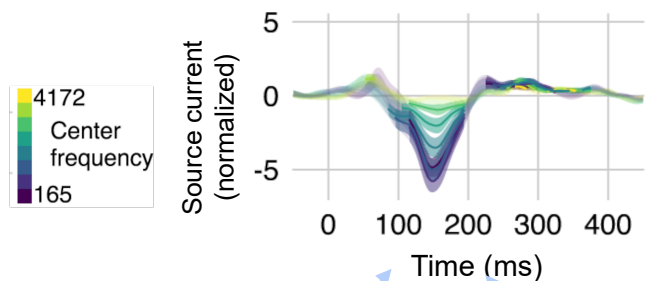


Speech stream segregation

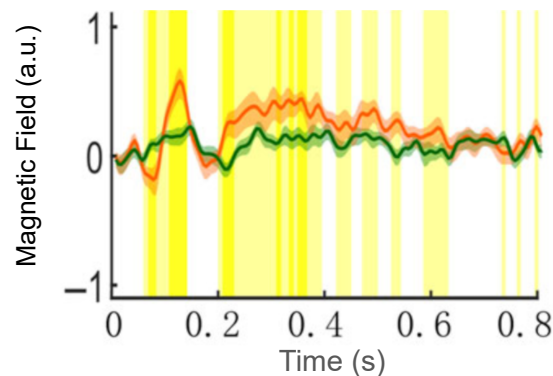


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Attentional effects begin around the N1 and may be sensitive to target repetitions



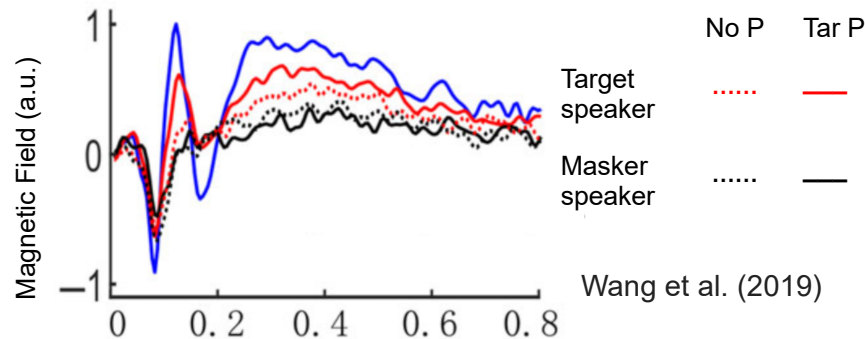
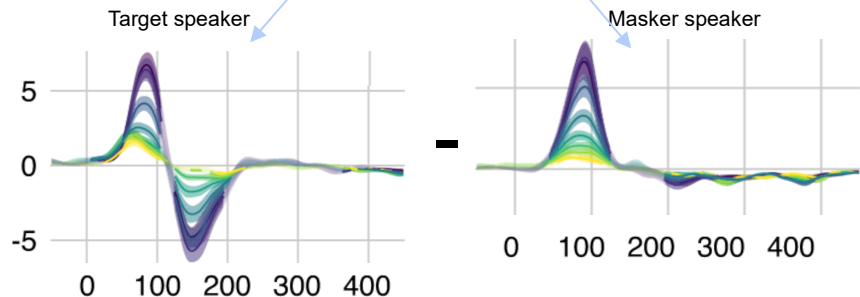
Brodbeck et al.
(2020)



No priming

Target priming

TRF show differential neural representations of foreground vs background objects



Wang et al. (2019)

Experience-dependent segregation

Attention increases the relative weight of a target (attentional effect, AE), yet familiarity with a stimulus (repetition) may *reduce* its cortical response.

How do attention and experience collaborate in the cocktail party (CP) neurally?

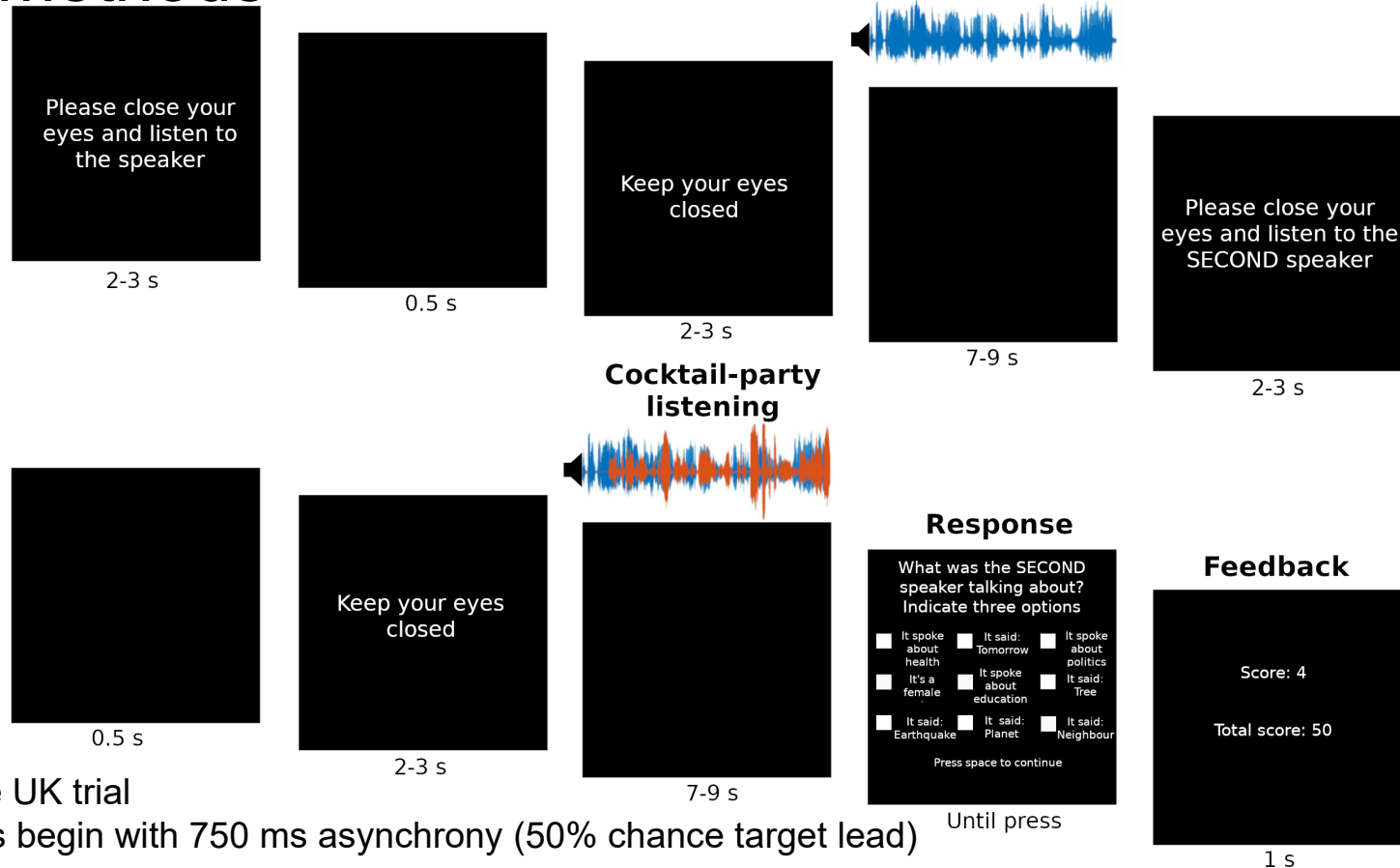
- Foreground experience may lead to a reduced AE (target attenuation)
- Background experience: increased AE (background suppression)

Key methods

- *Single-trial EEG* study, 30 listeners
- 250+ sentences and voices, >100 CP trials
- Report topic, keywords, age/gender of target (*CP comprehension task*)
- Priming of target ('attended-known'), or masker ('unattended-known'), or neither

Solo stim.	Politics	Gov't	Sports	Religion	Educ.	Keyword1	Keyword2	Keyword3	Keyword4	Male/ Female	Age
1		X			X	Biases	Brain	Financial	Invest	F	Younger
2	X					Retire	Write	Journal	Stuff	M	Older
3					X	Tourism	Illusion	Transform	Experience	M	Younger
...		X				Advances	Rights	Money	Depression	F	Older

Key methods



A sample UK trial

Speakers begin with 750 ms asynchrony (50% chance target lead)

Until press

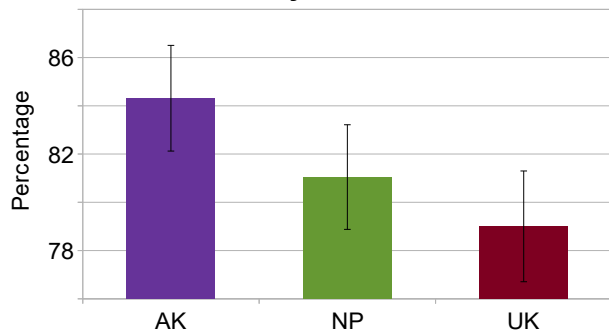
1 s

Results: behavior

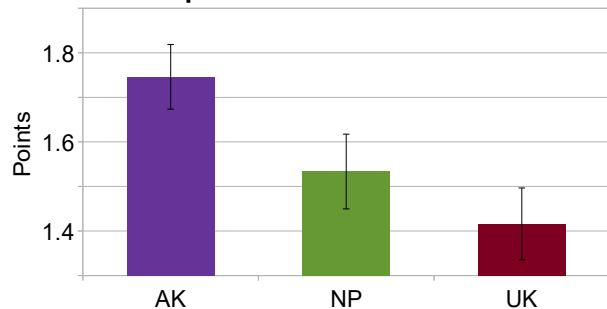


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Percentage of positive responses
by condition

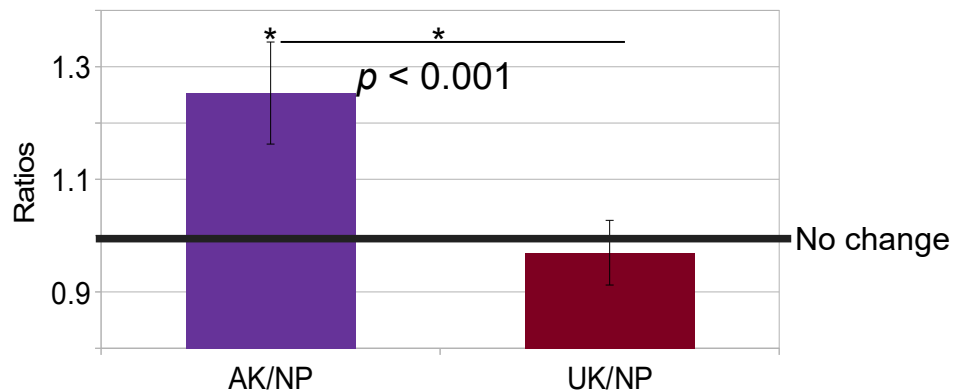


Score per trial in each condition



AK = target priming | UK = masker priming | NP = control

Score per trial ratios



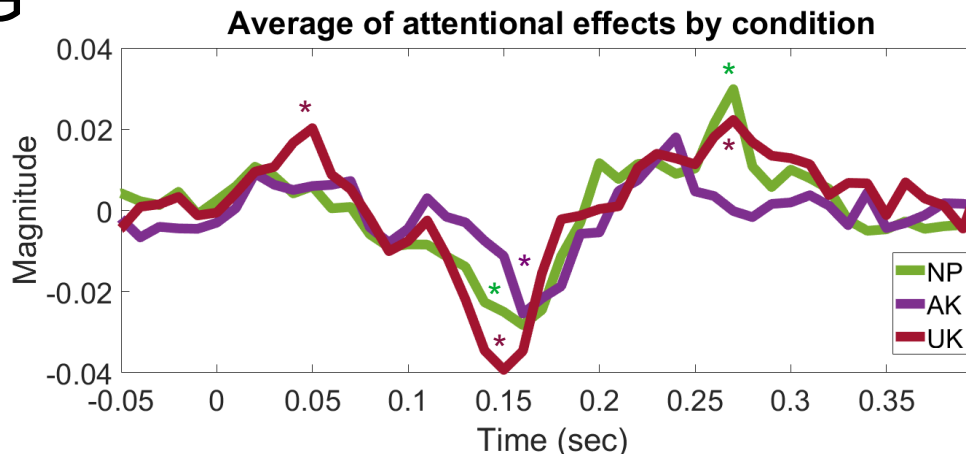
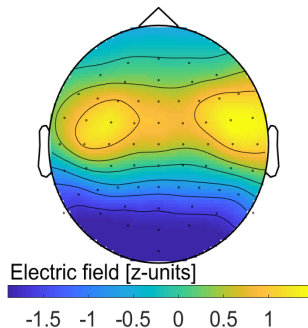
Target priming improves participants' scores (by 25% on average), while masker priming doesn't significantly change scores from control levels.

Results: EEG



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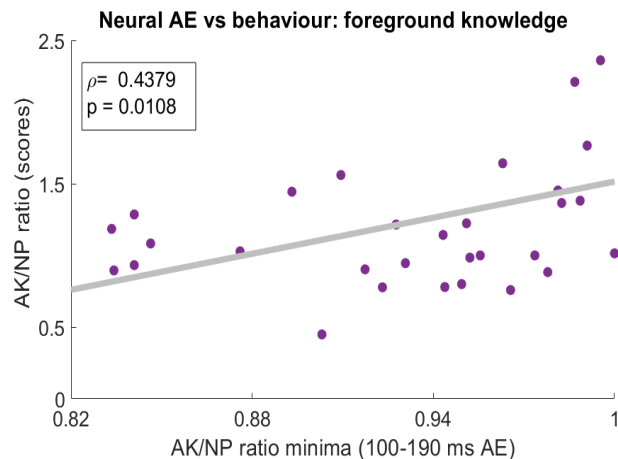
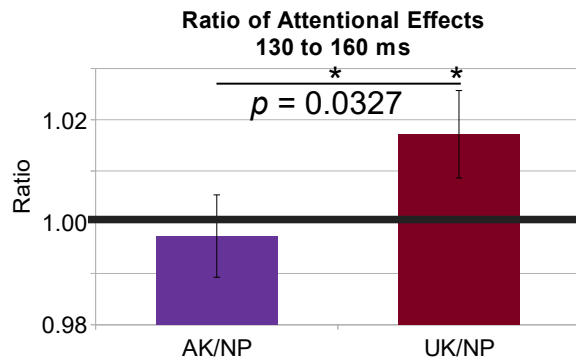
**Auditory EEG
response profile**



Priming affects AEs

Greater AE under
masker priming

No late AE under target
priming

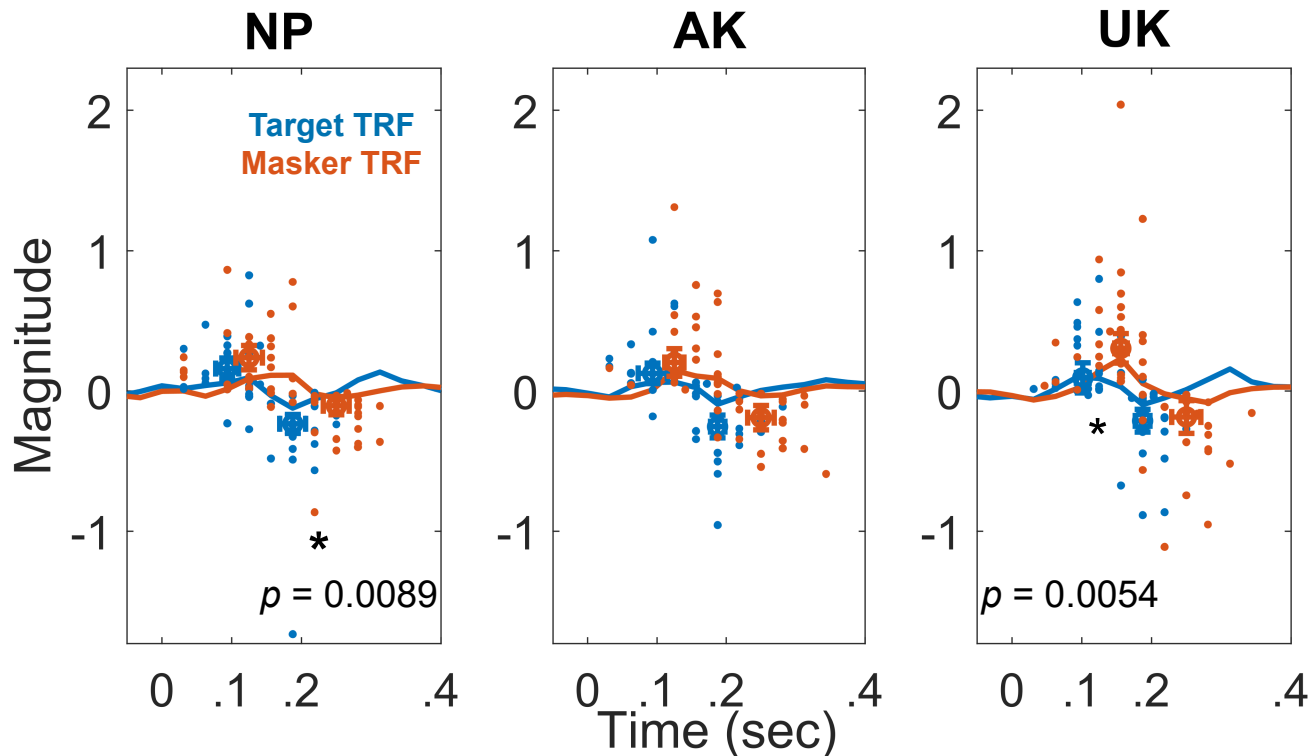


Target priming: a
correlation between
score increments and
AE decrements

An early AE also found
at 50 ms under masker
priming

Results: EEG

P1/N1 analyses and TRF grand averages



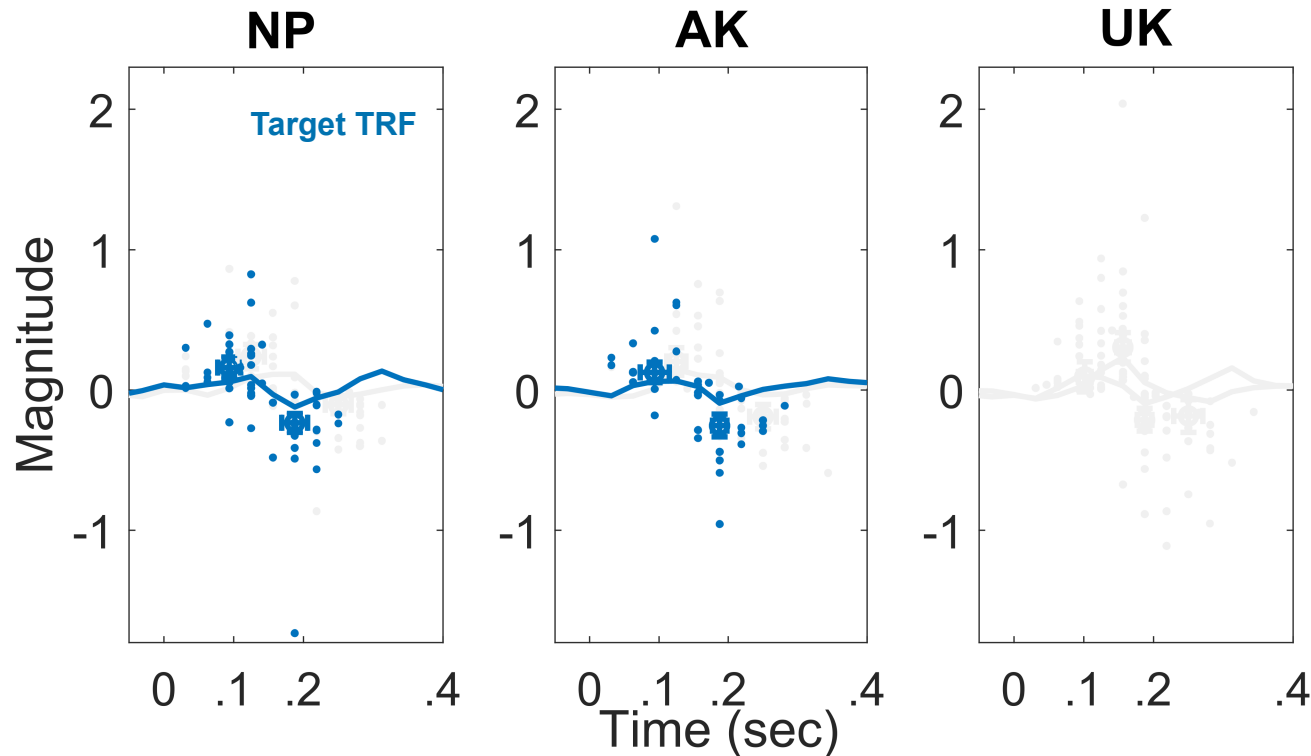
Tracking of attended speech is earlier than unattended speech in P1 and N1

N1 increase for the attended speech is observed in NP only

But UK instead shows P1 increase for the *unattended* speech

Results: EEG

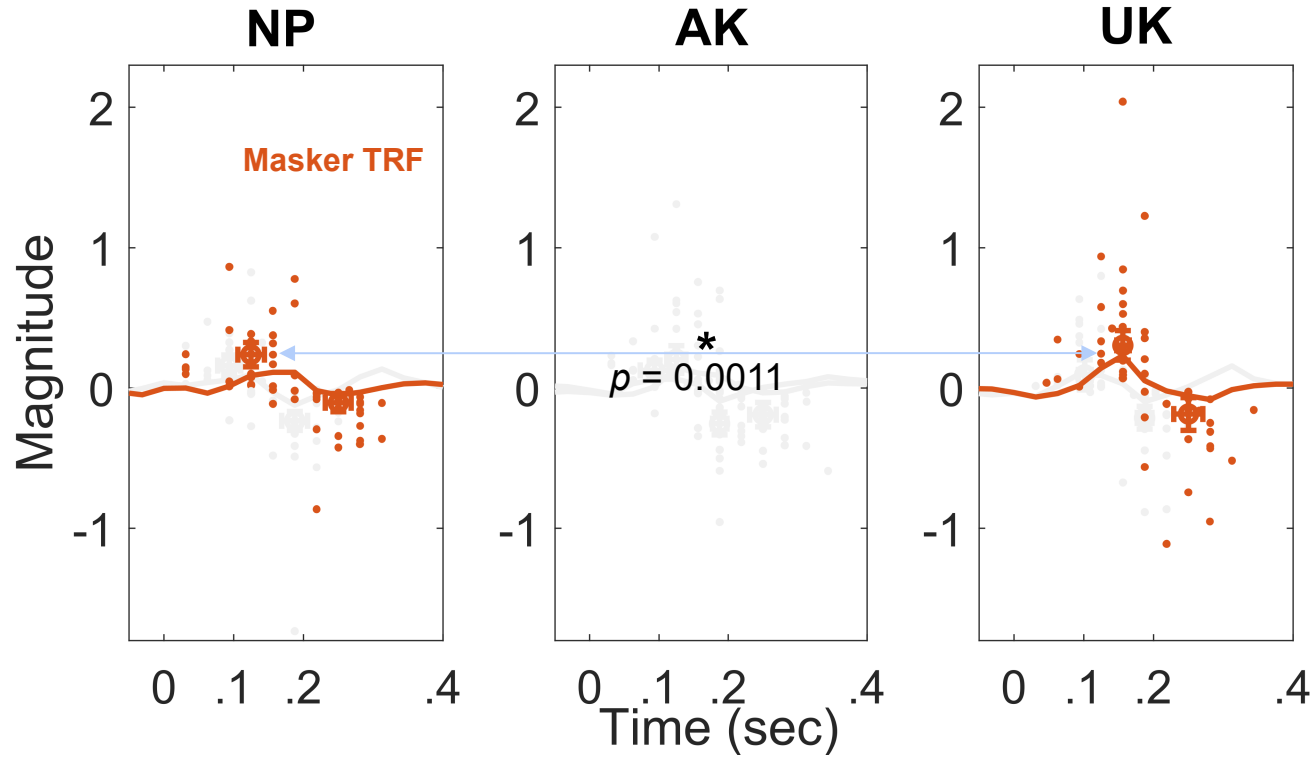
P1/N1 analyses and TRF grand averages



No latency or
amplitude differences
in P1/N1 for primed
vs unprimed attended
speech

Results: EEG

P1/N1 analyses and TRF grand averages



P1 increase for primed
versus unprimed
unattended speech.

- Target priming facilitates cocktail party behavior, but masker priming doesn't.
- Attentional effects (AE) change according to prior knowledge:
 - Following AK:
 - AE absent for late processing (250 to 300 ms)
 - Listeners whose AE is robust (i.e. not reduced) also benefit behaviorally.
 - Following UK:
 - AE increases but this is due to P1 not N1
 - An additional early 50 ms AE also found

- Masker's P1 changes with priming
 - Greater representation of ignored speakers at P1 when known.
 - AE increases following UK reflect changes to masker P1 rather than target N1.
 - Yet the earliest AE (around 50 ms) was due to faster P1 growth for *attended* speakers.
- Results suggest P1 sensitive to background at the CP
 - Preattentive suppression of a predicted masker at early stage
 - Predicted masker's representation delayed in P1 while target already being represented at N1 (contrast enhancement)

Thank you for your attention!

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