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Articulatory-motor regions in acoustically-degraded word processing - Converging evidence

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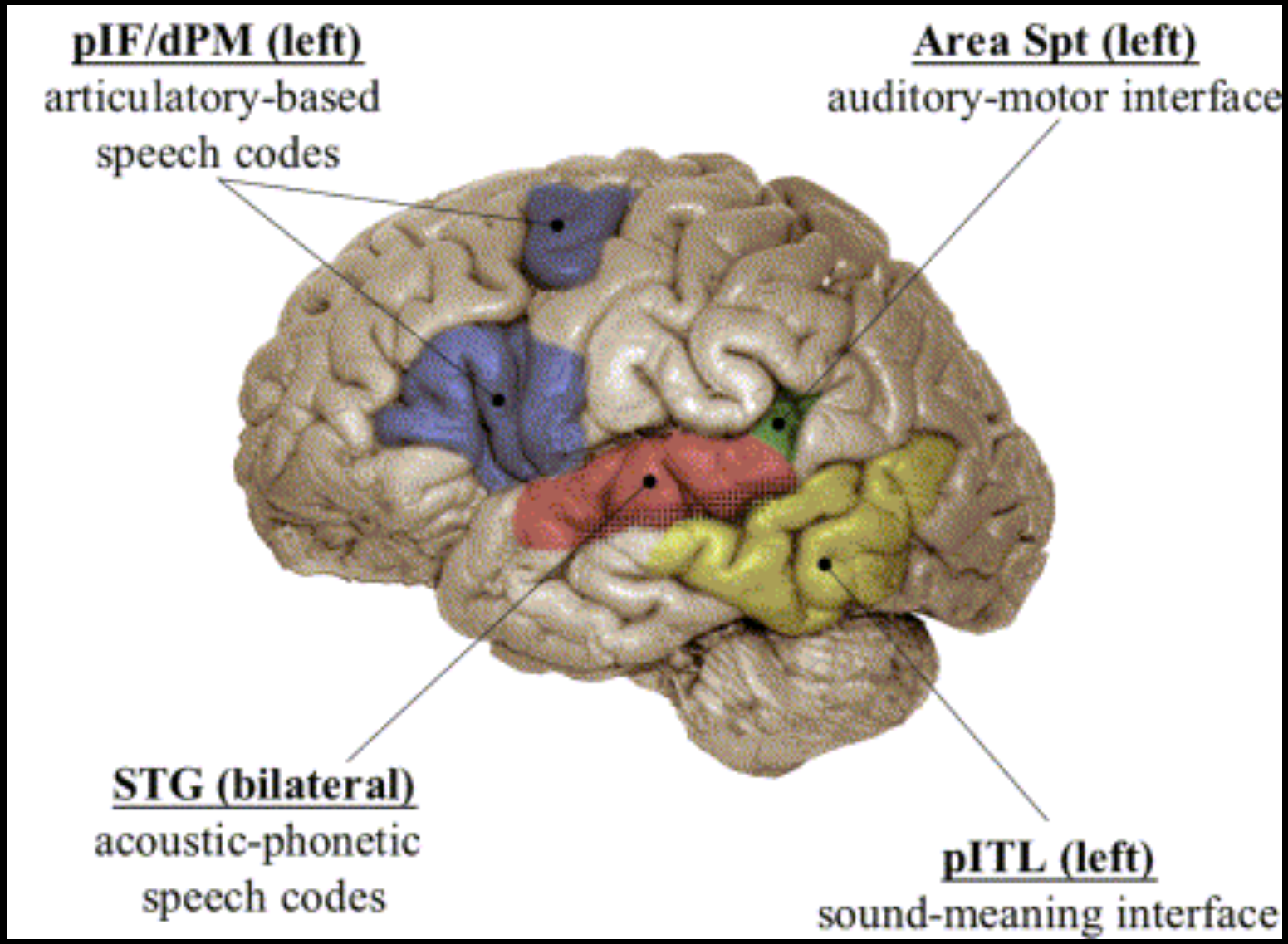
SPIN Workshop, Copenhagen, 9th January 2015

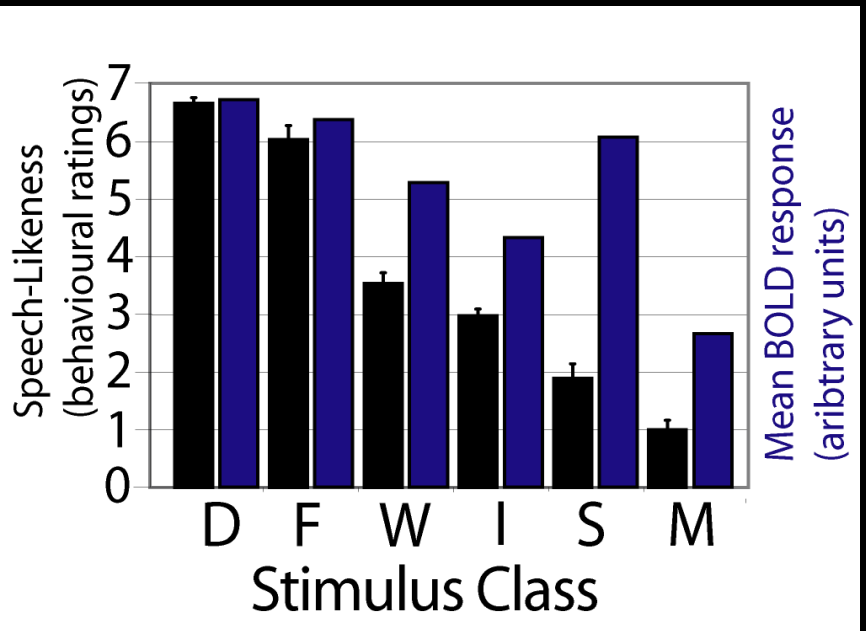
Functional Neuroanatomy of Language

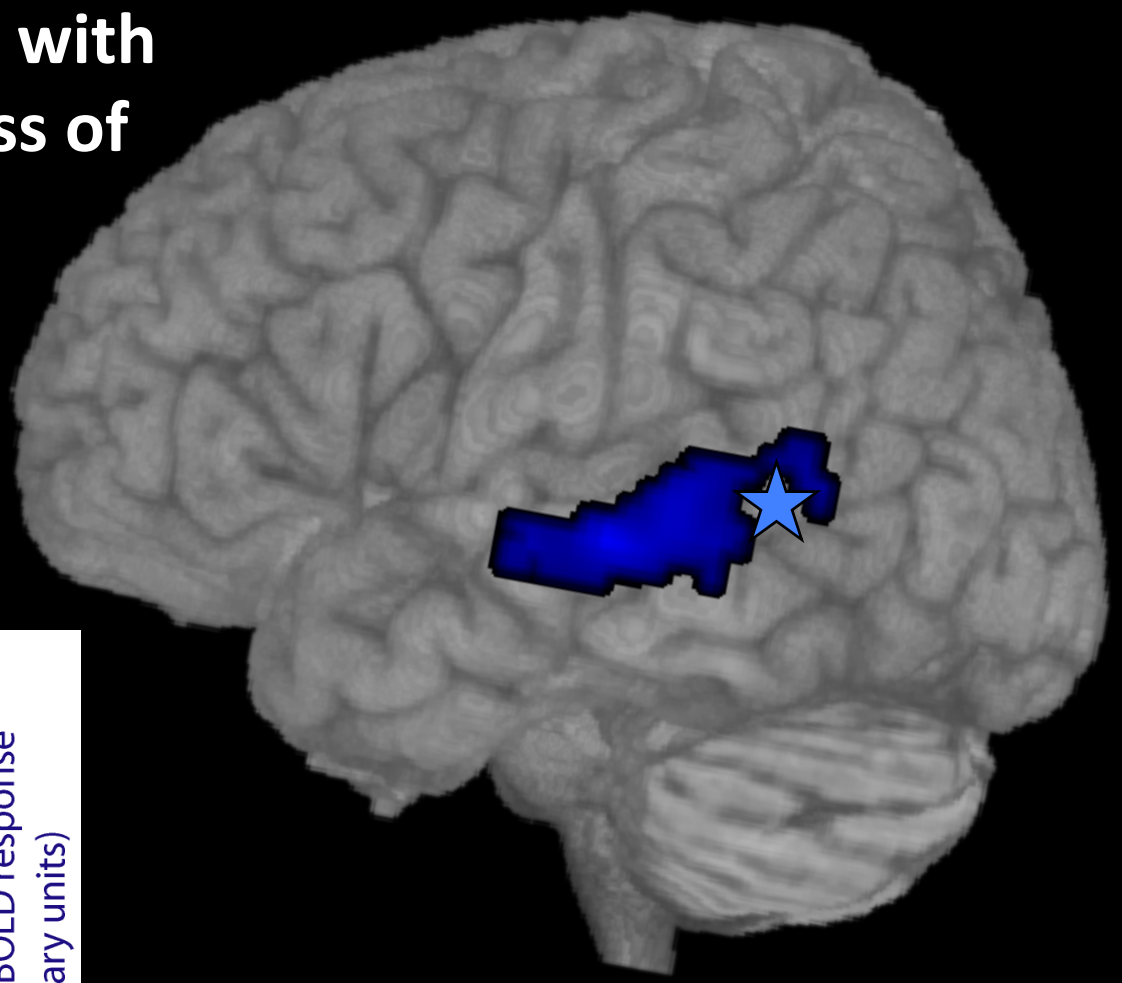


Taken from Hickok & Poeppel (2004) Cognition

Speech-Likeness Sensitivity

STS activation correlates with perceived speech-likeness of synthetic vowels
(cf. Belizaire et al., 2007)





Hervais-Adelman, et al. (unpublished preliminary data)

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Functional Connectivity to "Speech-Likeness" Regions

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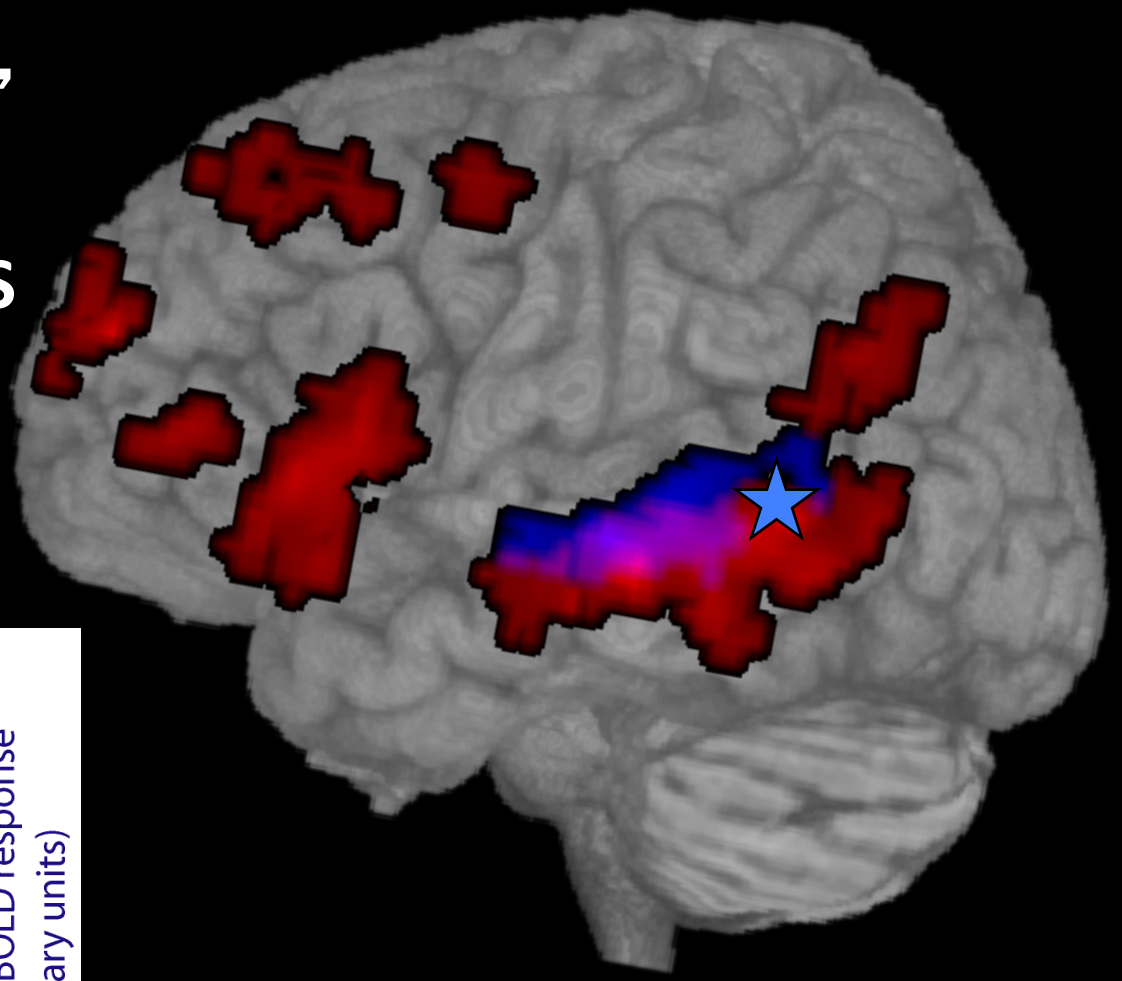
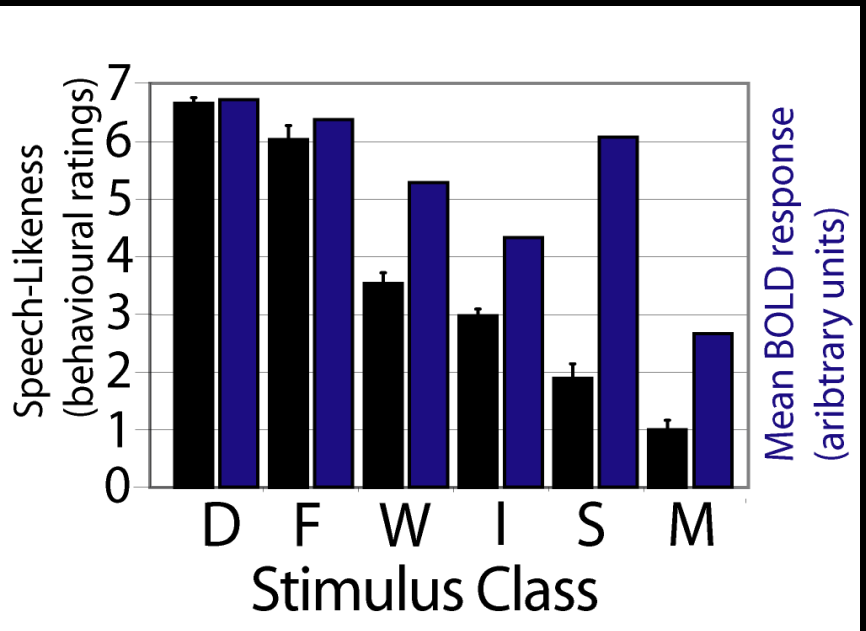
Co-activation of "speech-likeness region" and fronto-temporal network (MTG, ITG, pSTS LIFG, motor, DLPFC)





Hervais-Adelman, et al. (unpublished preliminary data)

Noise-Vocoded Speech

Shannon et al., (1995), Science

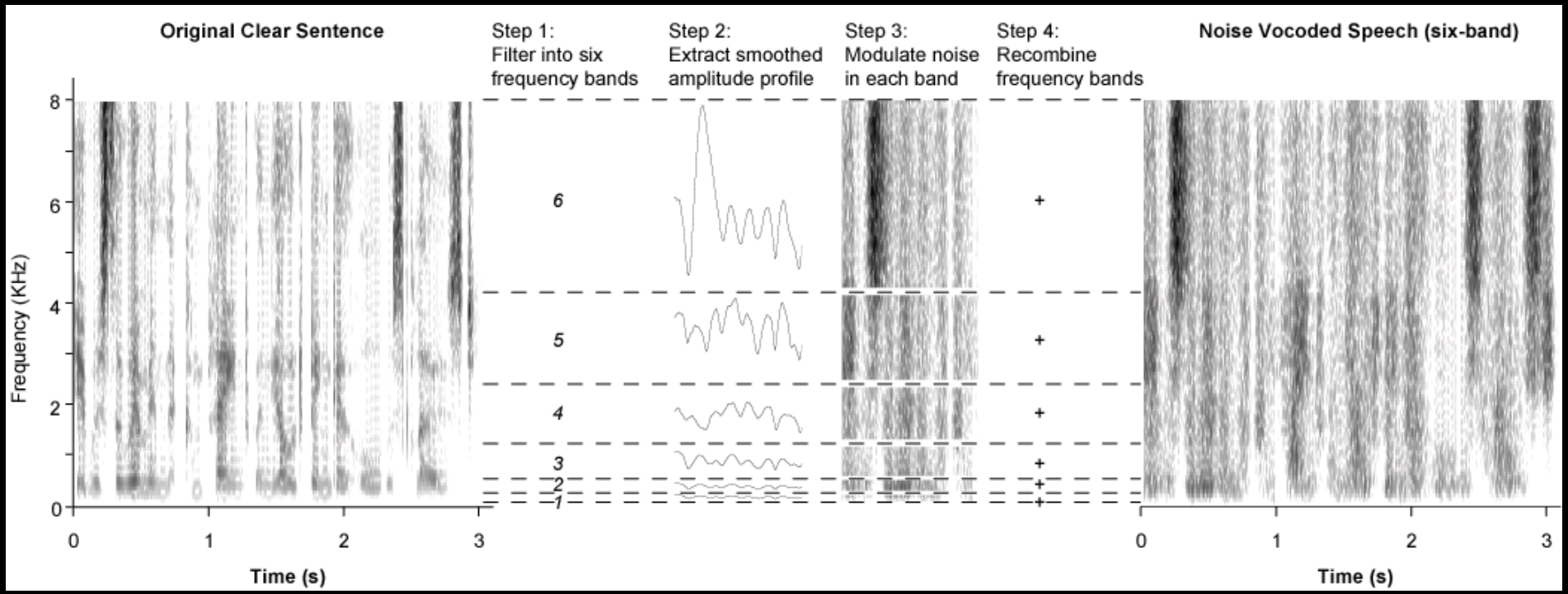


Figure from Davis, Johnsrude, Hervais-Adelman, Taylor & McGettigan (2005) JEP:Gen

Neural Correlates of Spectrally-Degraded Speech Perception

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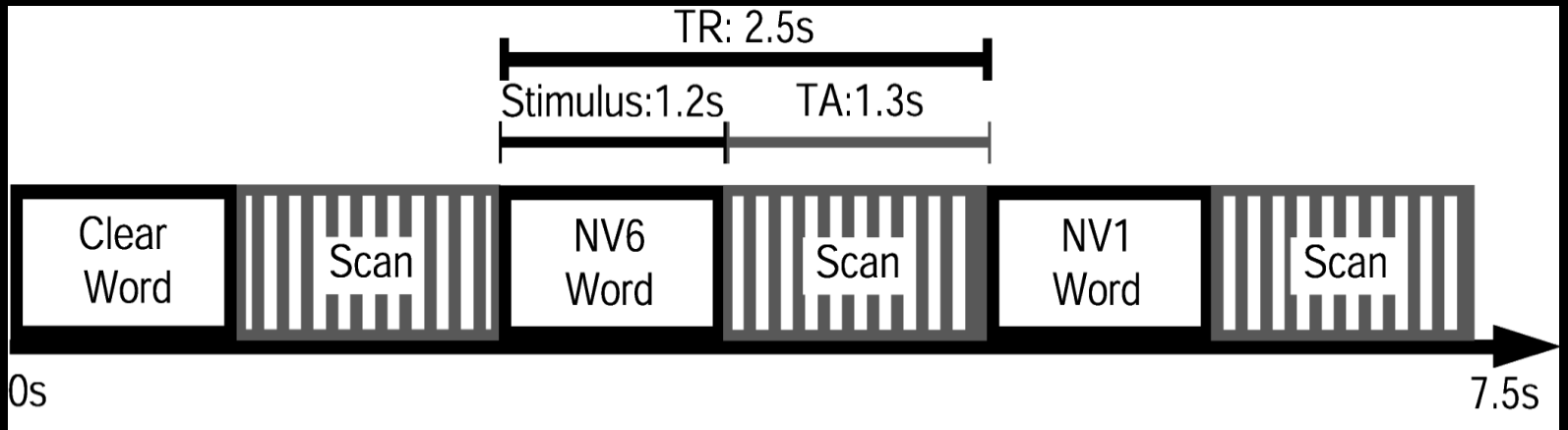
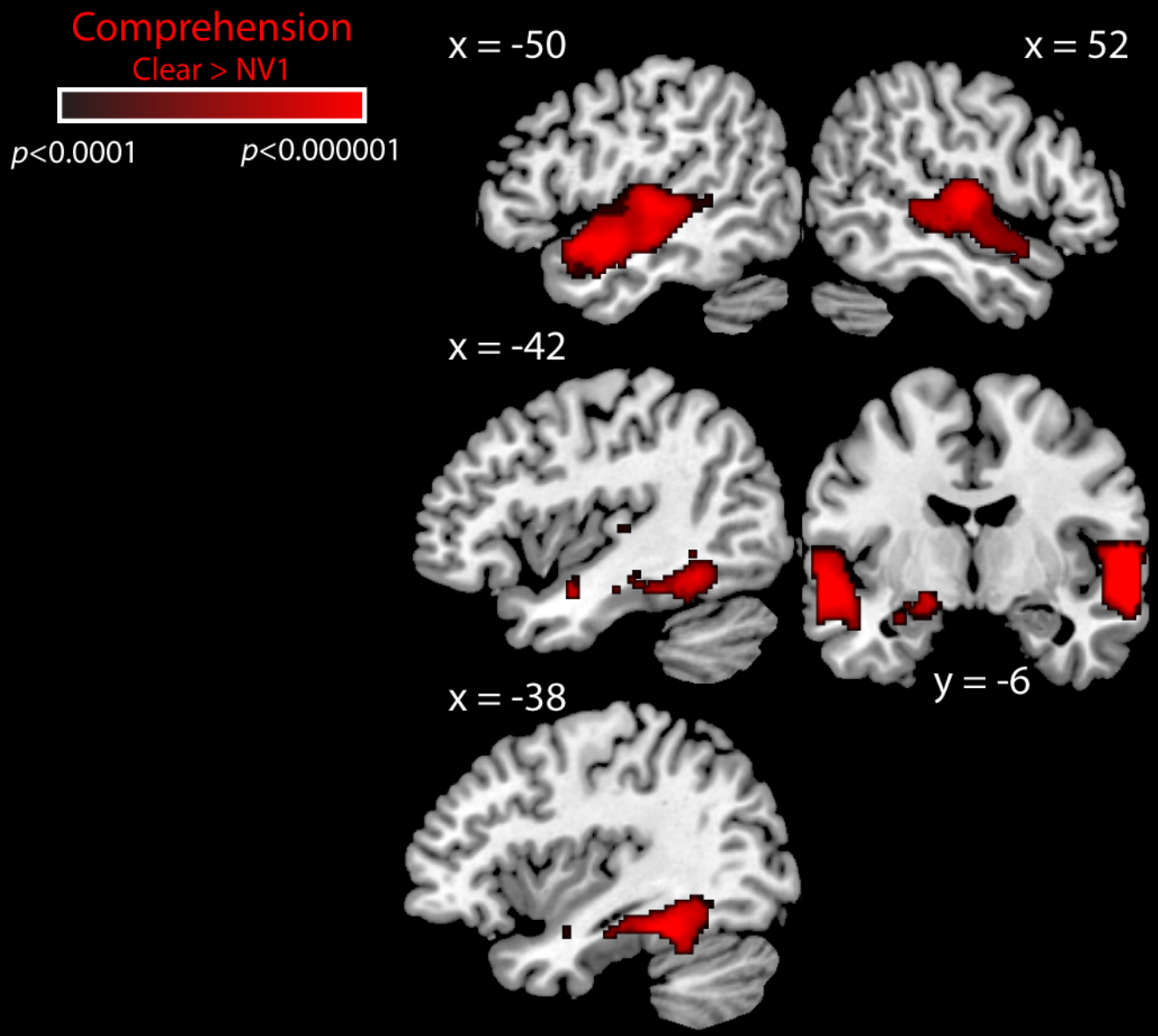
3 scan runs each containing:

- 50 Null events
- 50 Clear (C) words
- 50 Incomprehensible Speech (1-band noise-vocoded words, NV1)
- 50 Potentially Comprehensible Speech (6-band noise-vocoded words, NV6)

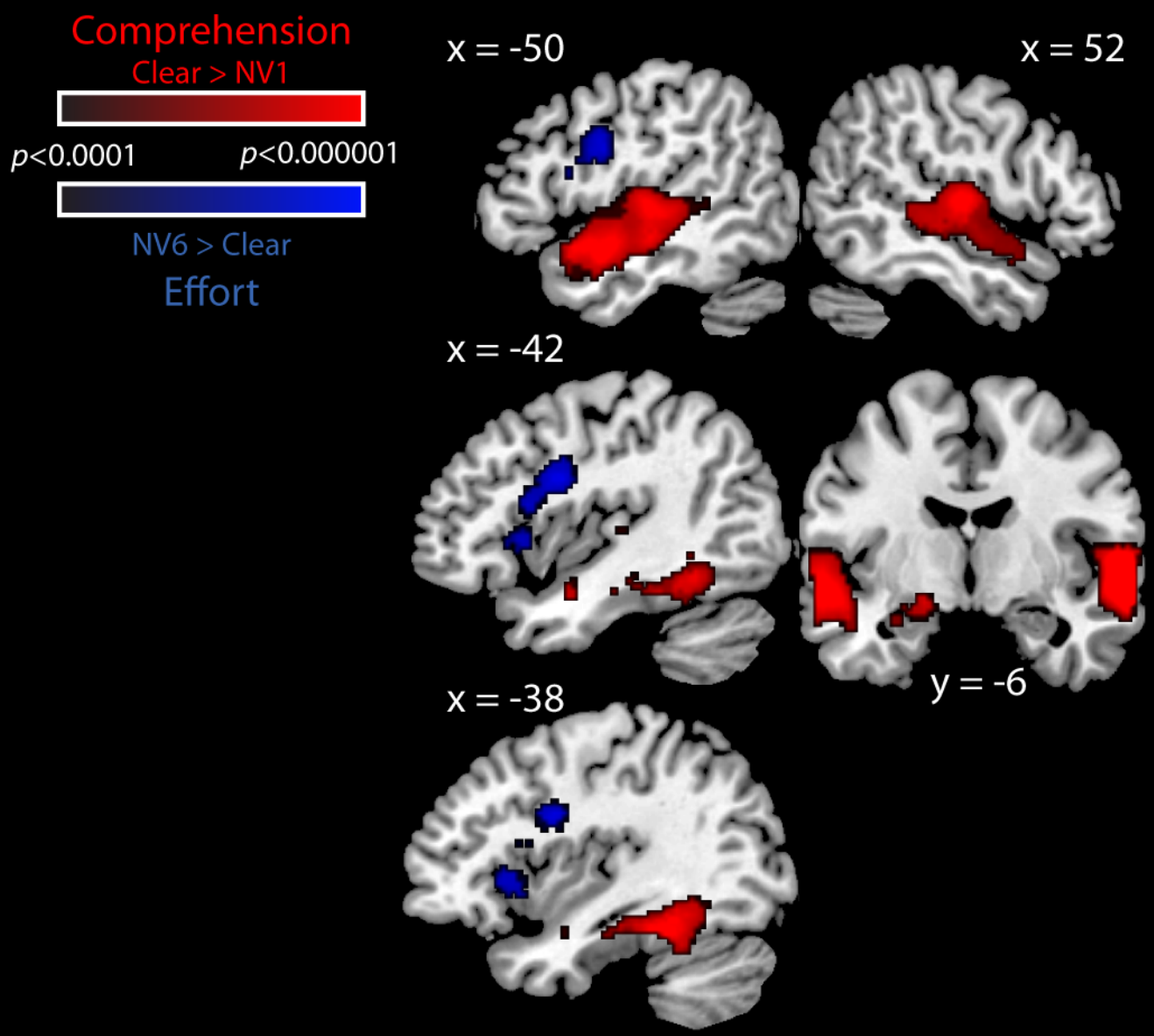
Task: button-press response to a “buzz” (1/12 trials)

Event-related sparse imaging

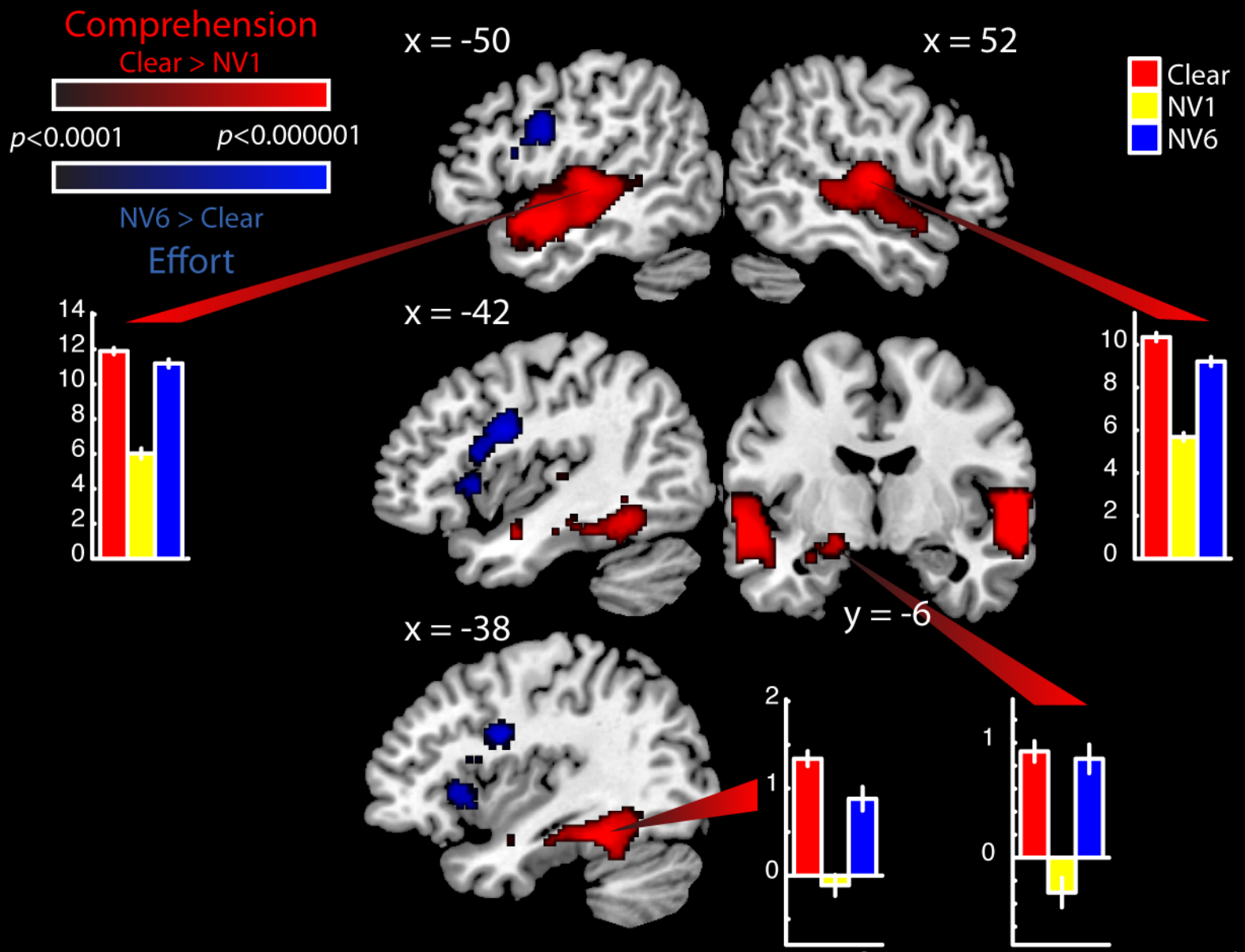




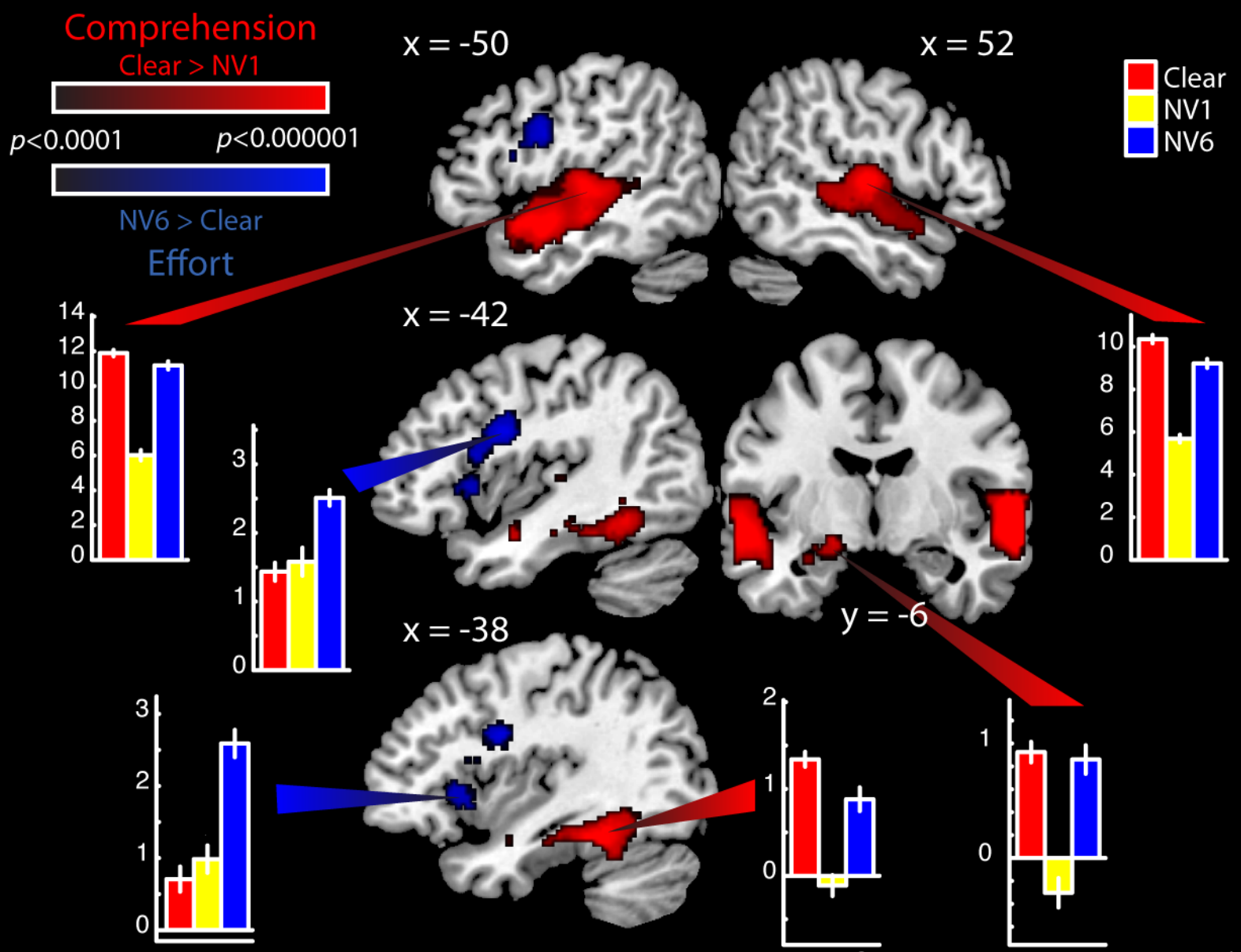
Hervais-Adelman, Carlyon, Johnsrude & Davis (2012), LCP



Hervais-Adelman, Carlyon, Johnsrude & Davis (2012), LCP



Hervais-Adelman, Carlyon, Johnsrude & Davis (2012), LCP



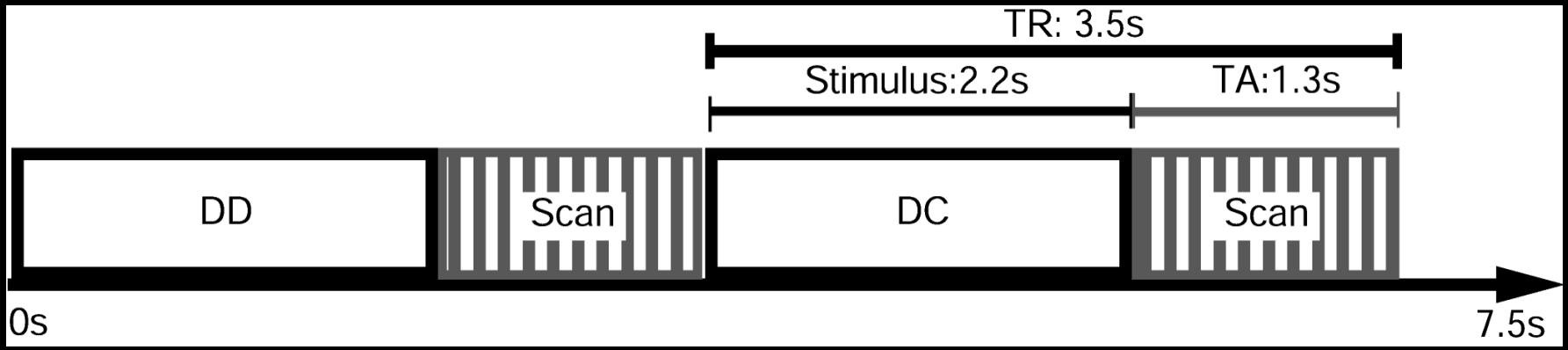
Hervais-Adelman, Carlyon, Johnsrude & Davis (2012), LCP

The Pop-Out Effect

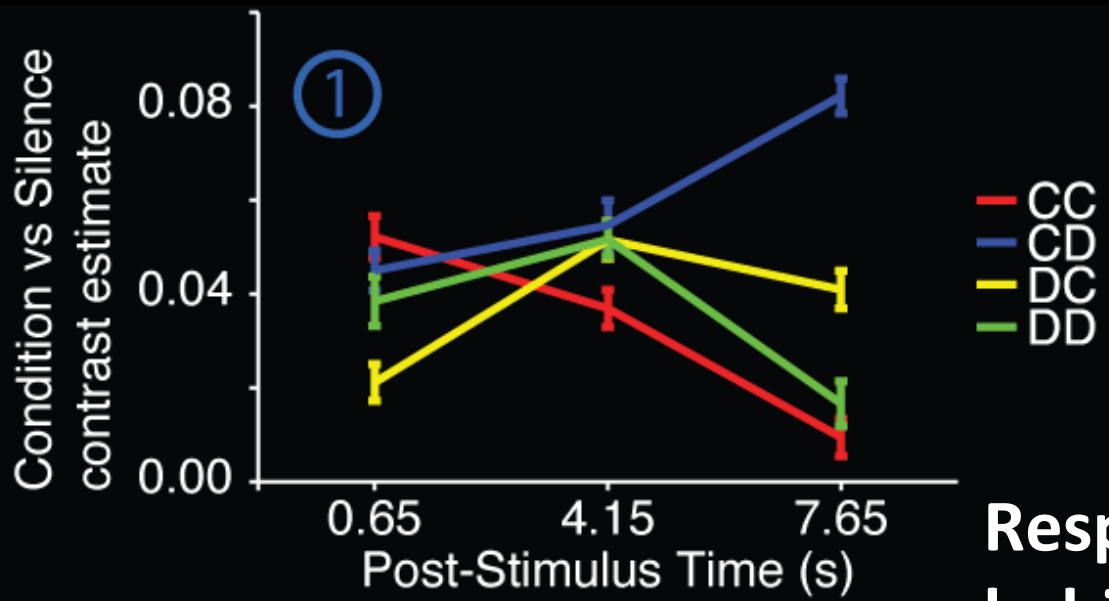
6-band NV words, 2 runs, each containing:

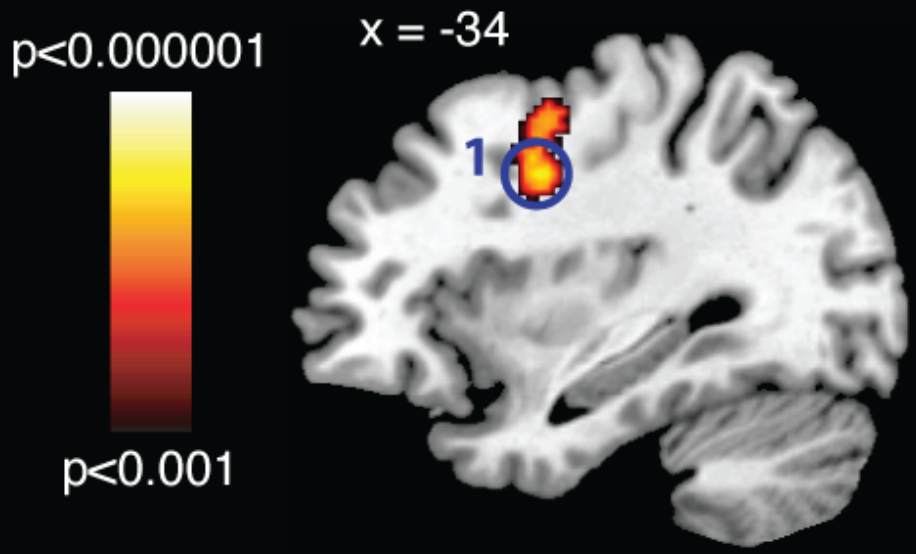
- 50 Null events
- 50 Clear-Clear pairs (CC)
- 50 Distorted-Distorted pairs (DD)
- 50 Distorted-Clear pairs (DC)
- 50 Clear-Distorted pairs (CD)*

Event-related sparse imaging



Pop-Out in Motor Cortex





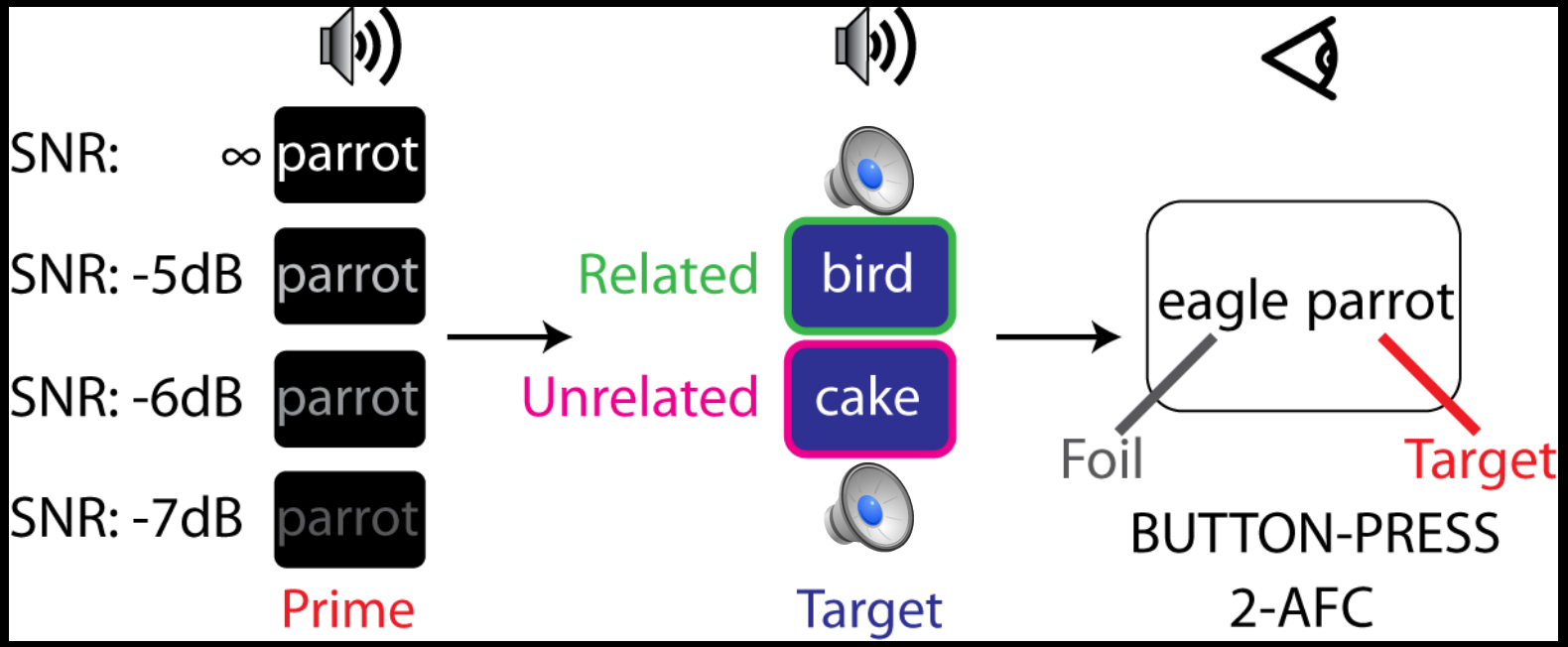
Response to CD lags behind that of the other conditions

Putative locus of pop-out: in left ventral primary motor cortex

Hervais-Adelman, Carlyon, Johnsrude & Davis (2012), LCP

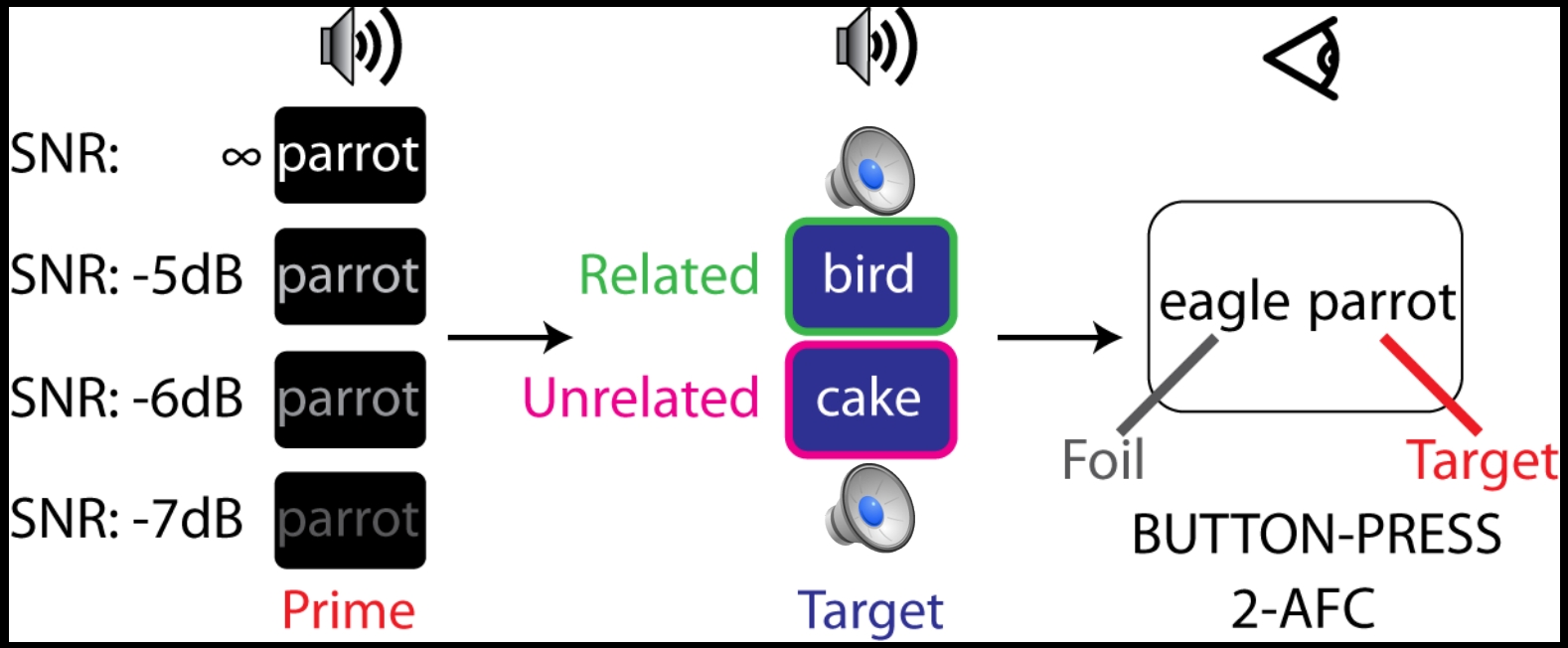
Fortuitous Findings: Masked Backward Semantic Priming

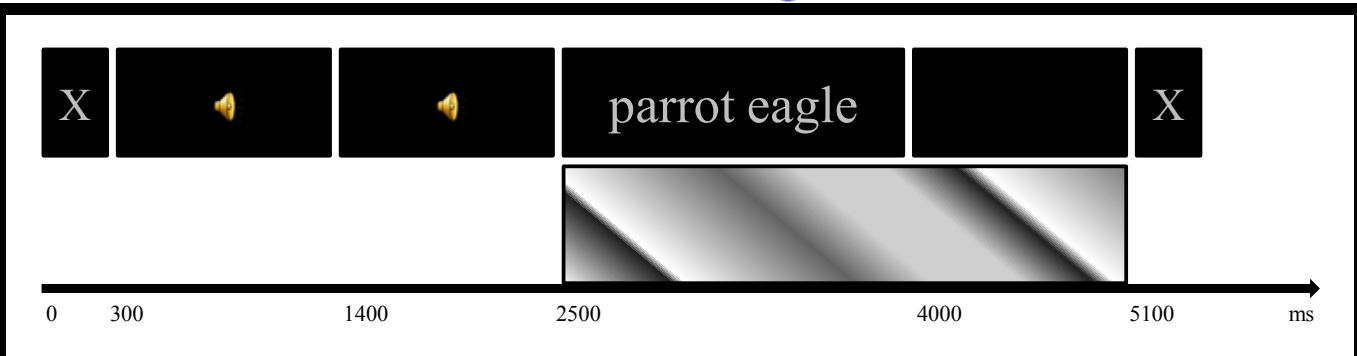
- Design based on Golestani, Rosen & Scott, 2009:



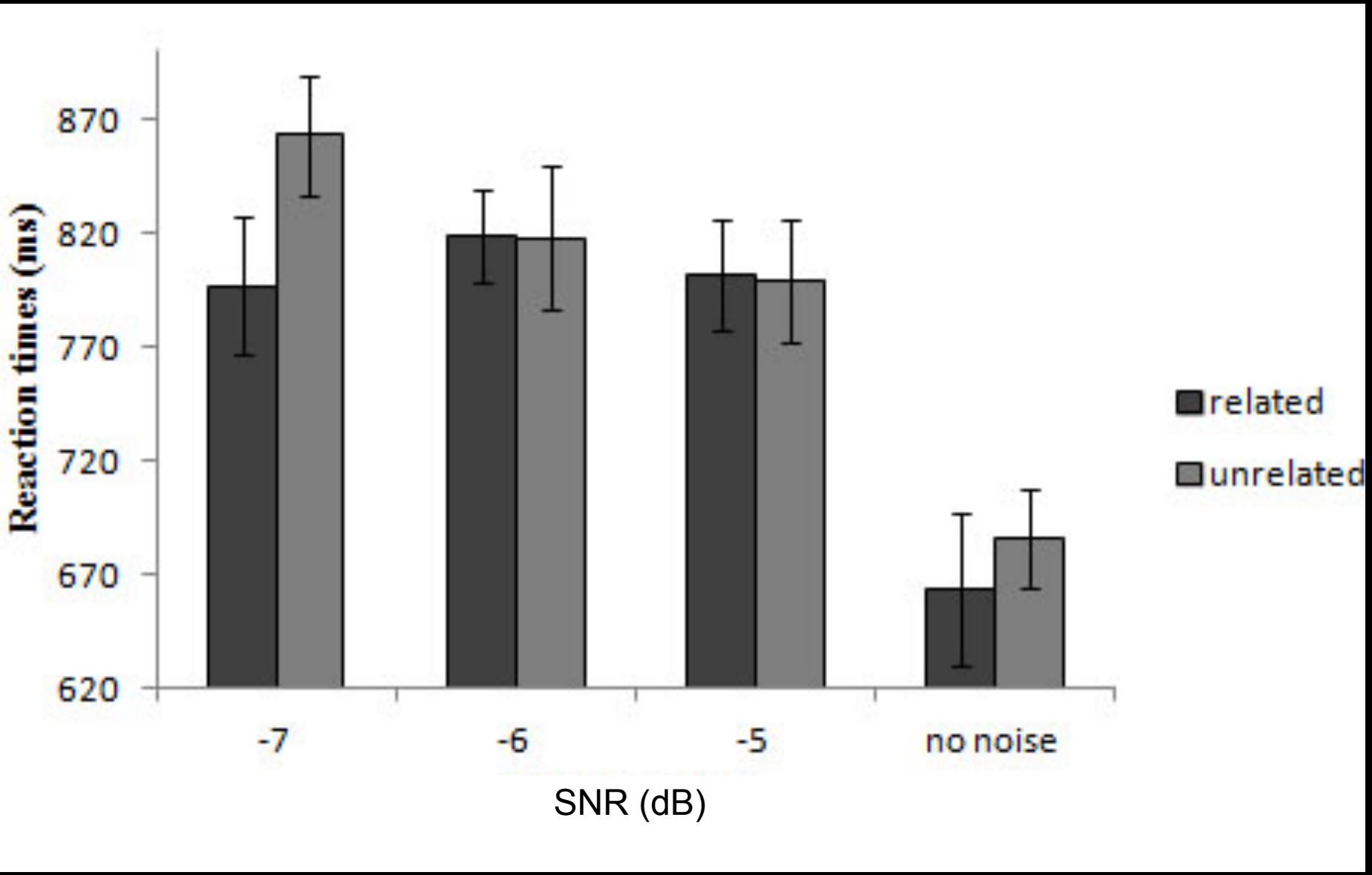
Fortuitous Findings: Masked Backward Semantic Priming

- Design based on Golestani, Rosen & Scott, 2009:





Masked Backward Semantic Priming: Behavioural Results



Golestani, Hervais-Adelman, Obleser & Scott (2013), NeuroImage

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Masked Backward Semantic Priming: fMRI

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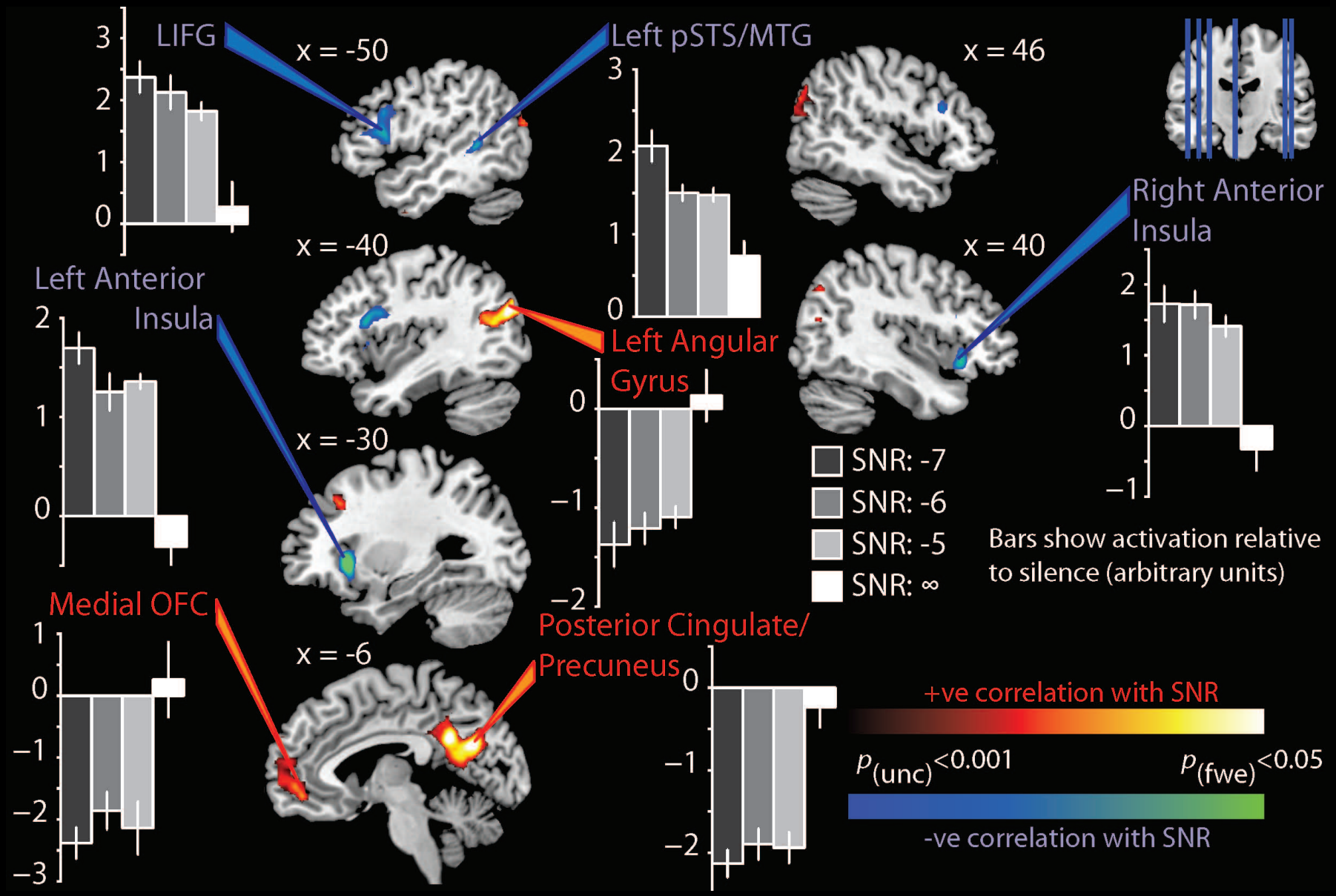
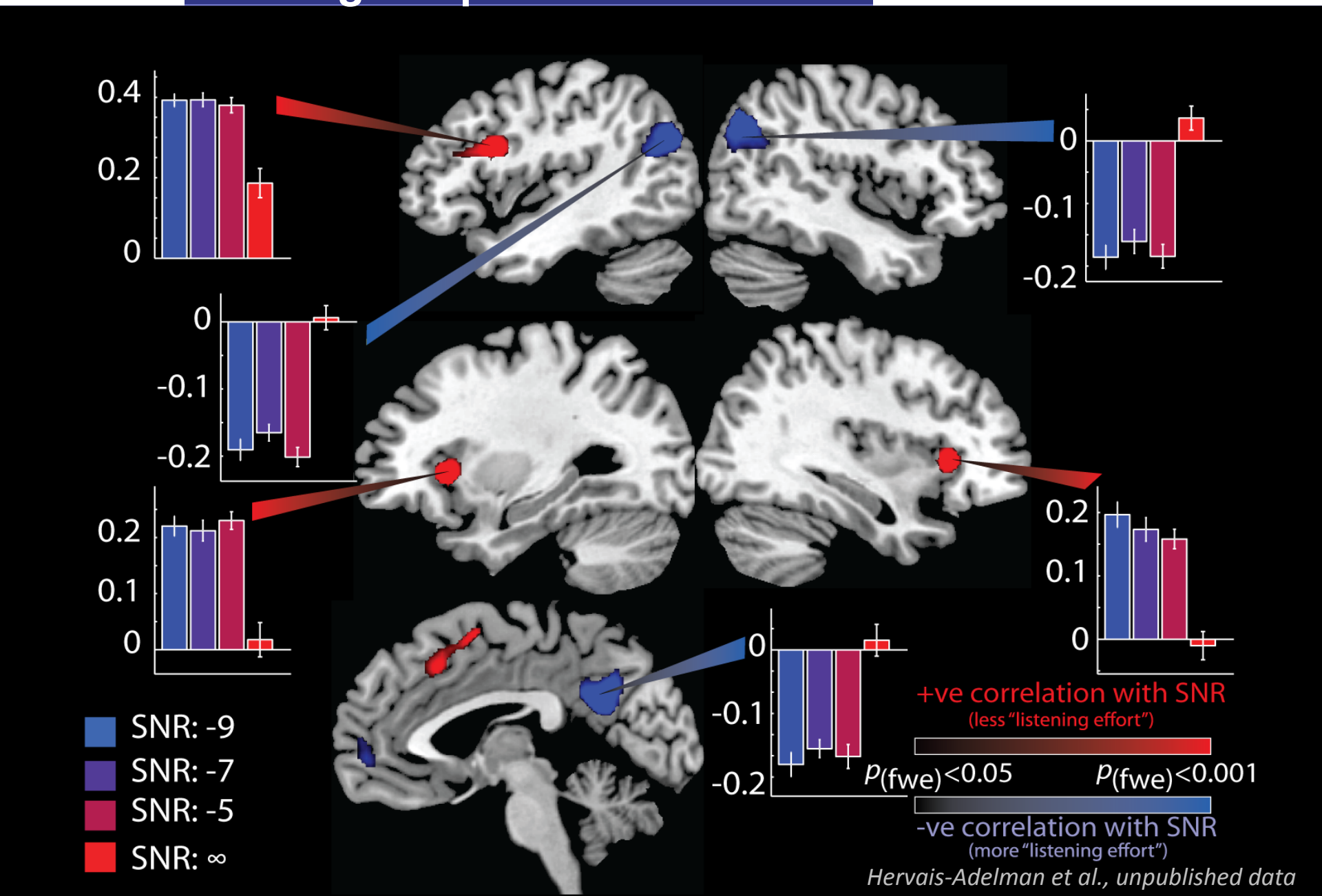


Golestani, Hervais-Adelman, Obleser & Scott (2013), NeuroImage

Masked Backward Semantic Priming - Replication



Hervais-Adelman et al., unpublished data

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SPIN + NV Convergence

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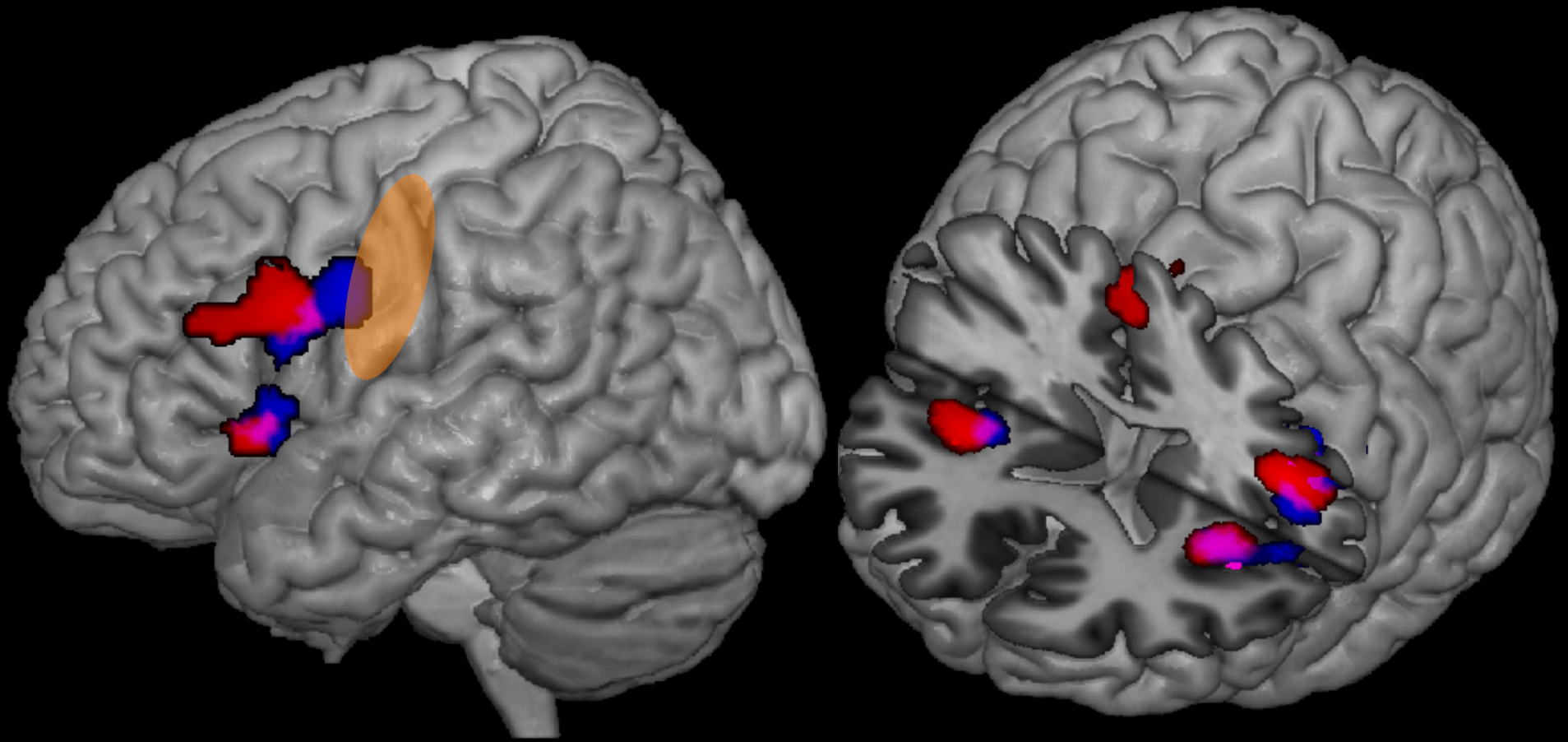
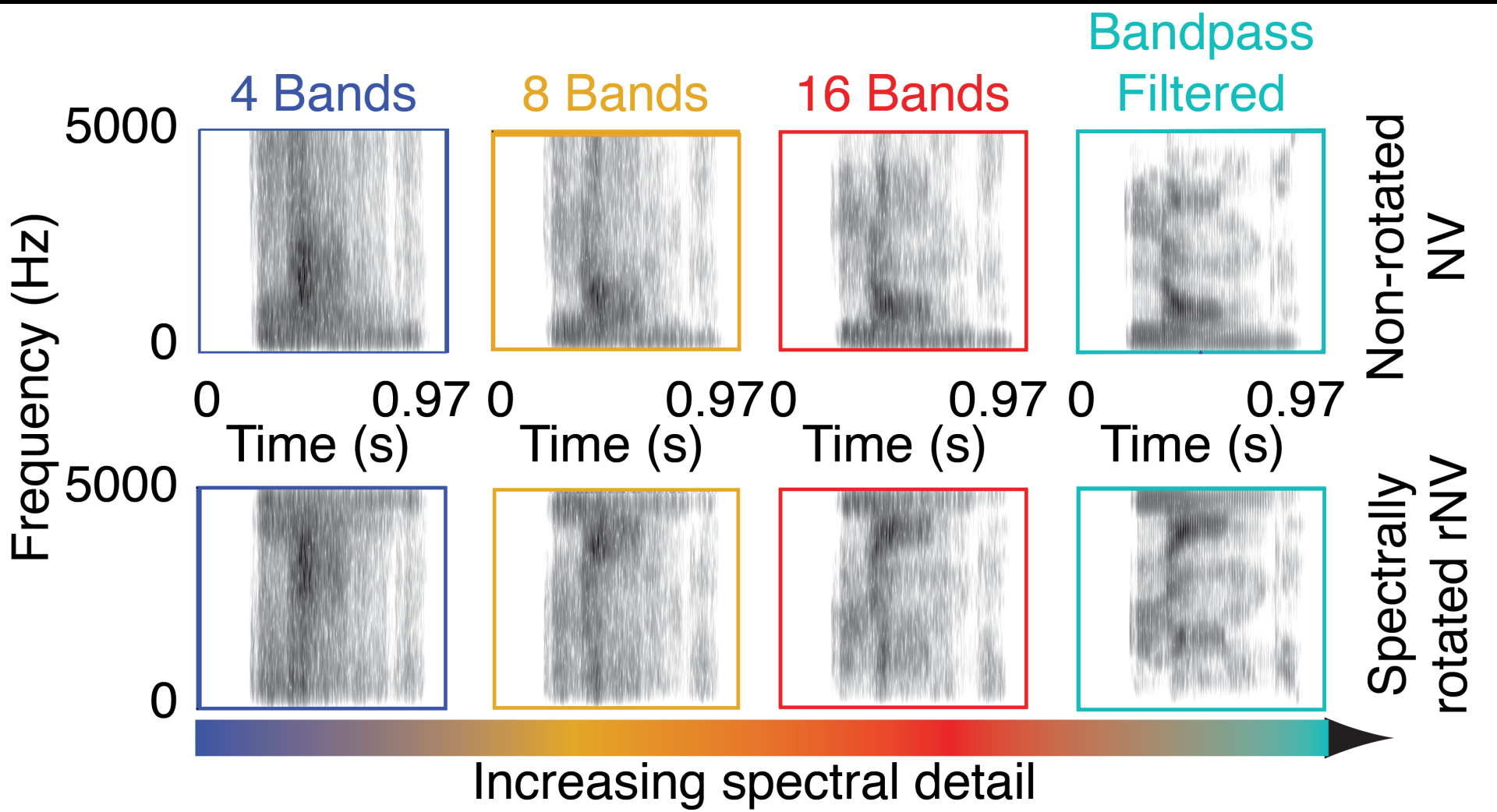
Listening Effort:
Degraded speech

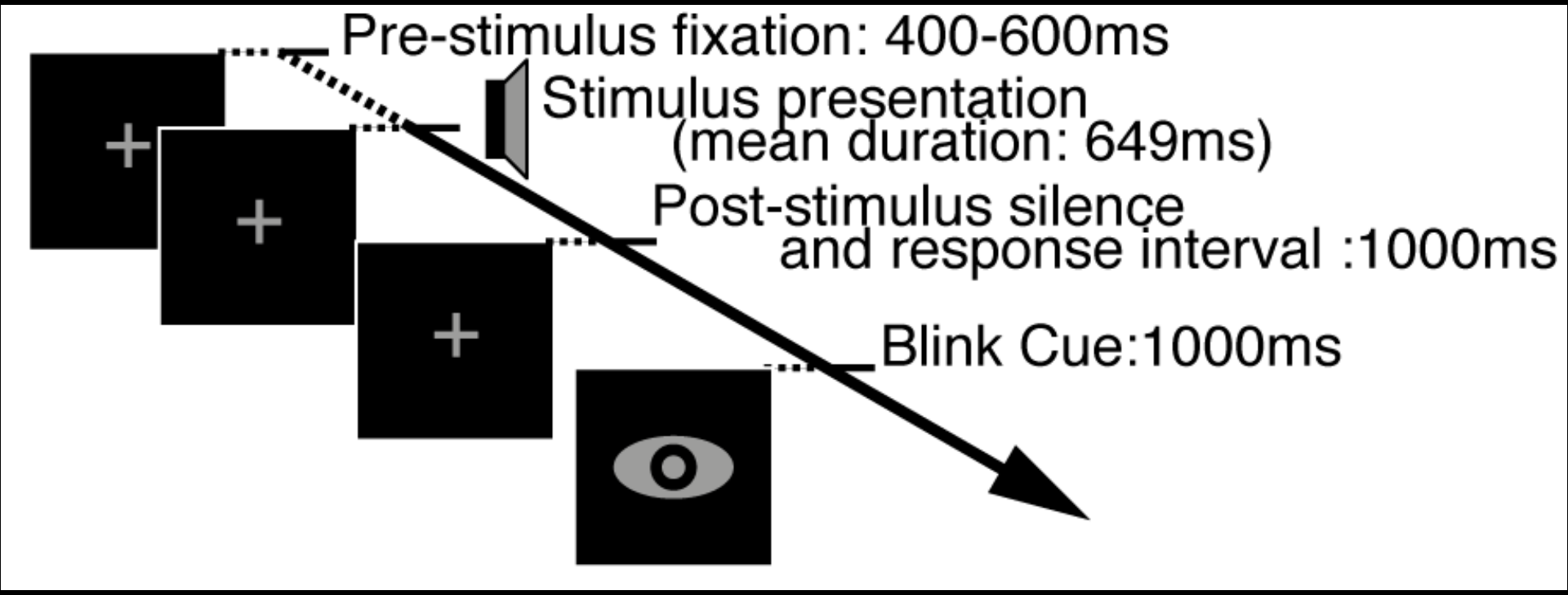
Listening Effort:
Speech in noise



The quest continues in EEG



EEG Paradigm



- 204-channel EEG, N=14 (2 male)
- Isolated monosyllabic words (French)

- Animal name detection task (1/9 trials)

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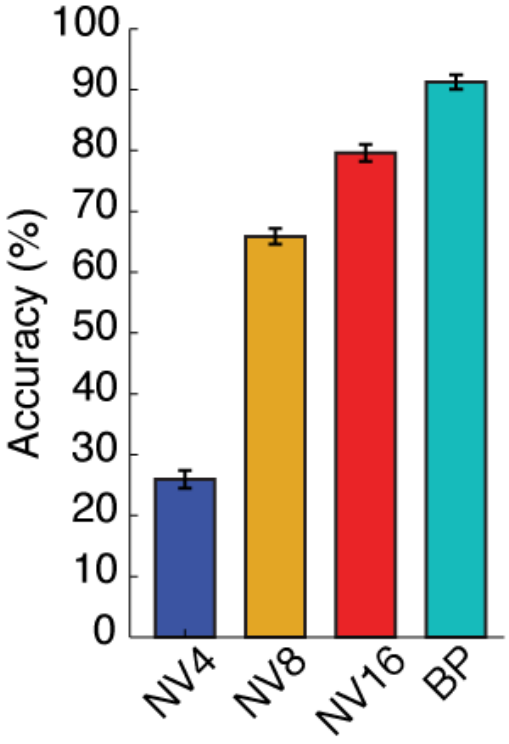
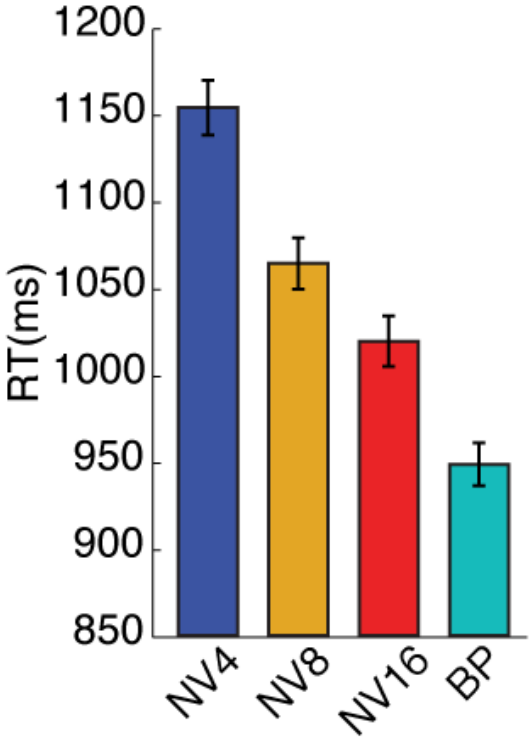
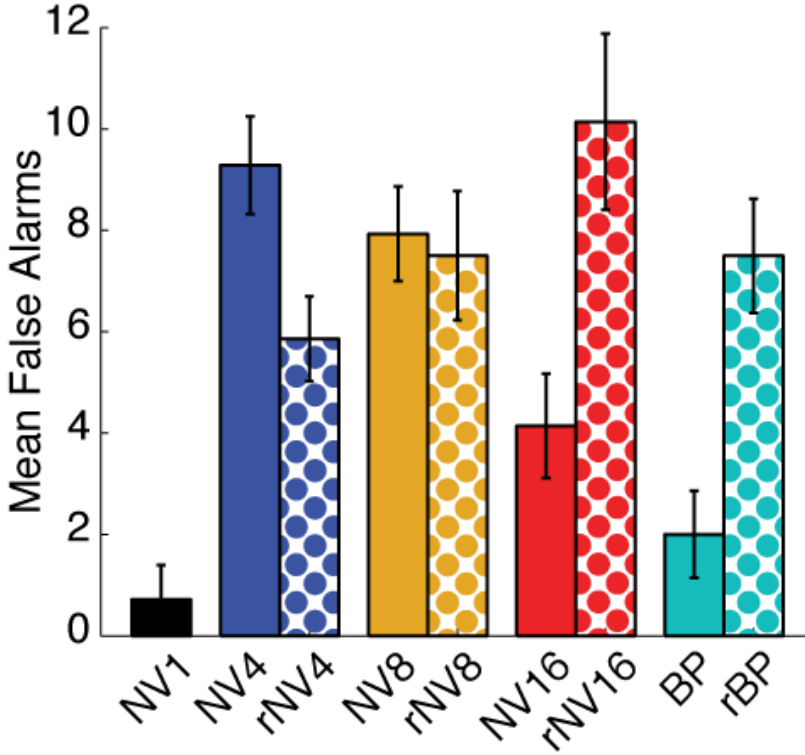
Behavioural Data







- Main-effect of number of channels on detection
- Spectrally-Rotated NV stimuli seem to sometimes evoke word percept

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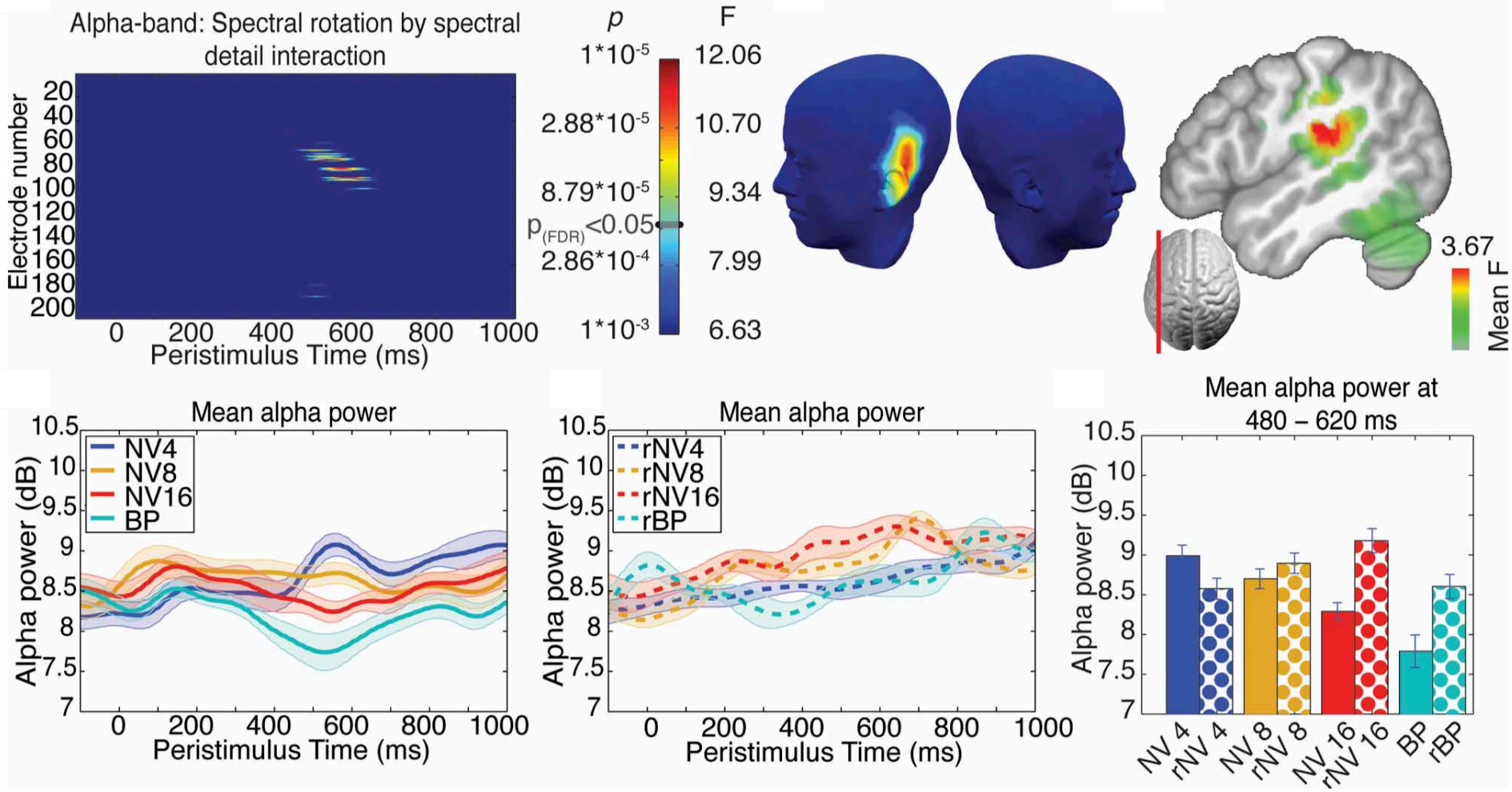
Alpha Suppression: Rotation*Complexity Interaction



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Summary

- Converging evidence from fMRI implicates motor/ premotor articulatory regions, and anterior insula(e)
- EEG data points to significant role for articulatory-auditory integration processes in degraded speech comprehension
- TMS data from other groups suggests causal role for articulatory regions in phoneme identification (Möttonen & Watkins, 2009, 2012; D'Ausilio et al, 2009) and word comprehension (Schomers et al., 2014)

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The role of articulatory structures in degraded speech?

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- Generator of set of potential matches for auditory input that has no existing template?
- Source of top-down constraint on prelexical search space?
- Comparator in a predictive coding framework?
- "Processing Hub", amodal, but conveniently connected to auditory association areas?

Acknowledgments

MRC Cognition and Brain Sciences Unit, Cambridge, UK
- Matt Davis
- Robert P Carlyon

Queen's University, Canada
- Ingrid Johnsrude

University of Geneva, Switzerland
- Narly Golestani, Brain and Language Lab
- Christoph M Michel, Functional Brain Mapping Lab
- Robert Becker, Clinical Neuroscience
- Maria Pefkou, Auditory Language Lab