Audiovisual Entrainment to Pseudo-speech Signals

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BACKGROUND

Speech detection thresholds for AV < A-alone [1]
Best for correlated auditory and visual envelopes

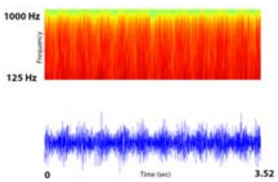
How is envelope correlation tracked across modalities?
Signal transmission rates, processing areas differ

Current Experiment:
Measure steady state responses (SSR) using MEG
measure entrainment to periodic A,V, and AV stimuli
-at a speech-relevant modulation frequency
-with synchronous or asynchronous envelopes

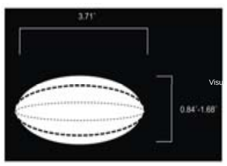
Predictions:
1. **Increase in SSR power for A+V modulated stimuli**
2. **Envelope asynchrony may reduce entrainment response**

PSEUDO-SPEECH AND MEG DESIGN

A+V modulated stimuli: modulation frequency (F_m) 3.125 Hz (T= 320 msec)



Auditory pseudo-speech: amplitude-modulated (AM) 3-octave pink noise

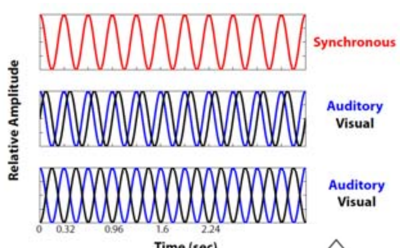


Visual pseudo- mouth: radius-modulated (RM) ellipse

Unimodally-modulated controls:
Audio: AM pink noise + static white rectangle;
Visual: RM ellipse + approx. Gaussian white noise

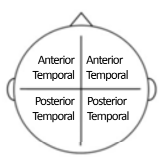
Envelope synchrony:

In phase
Visual envelope shifted 90° (80 msec delay)
Visual envelope shifted 180° (160 msec delay)

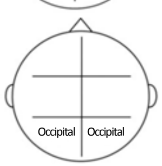


Analysis:
1. Separation of sensor space into A and V response areas
2. Unimodal A and V SSR pretests to determine max response sensors for each participant for each modality
3. FFT and determination of RMS power
4. Power grand averages (RMS of RMS)
5. GLMs on dB power (factors: Hemisphere, Harmonic, Condition, Sensor Area)

Auditory Sensor Division



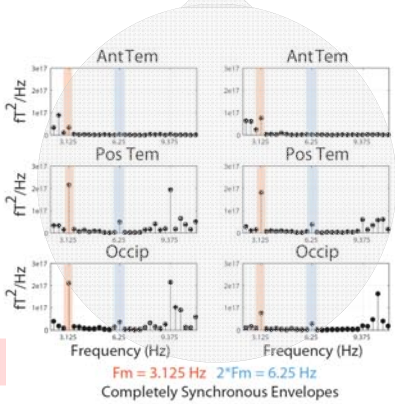
Visual Sensor Division



RESULTS

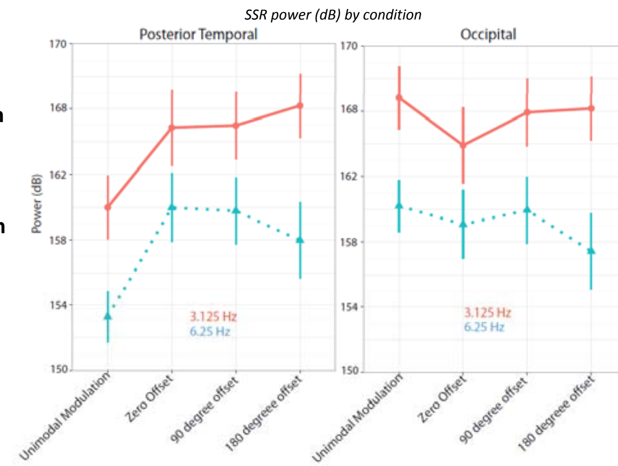
SSR reliably elicited to A+V pseudo-speech signals

Grand averaged linear SSR power *(n = 14)*



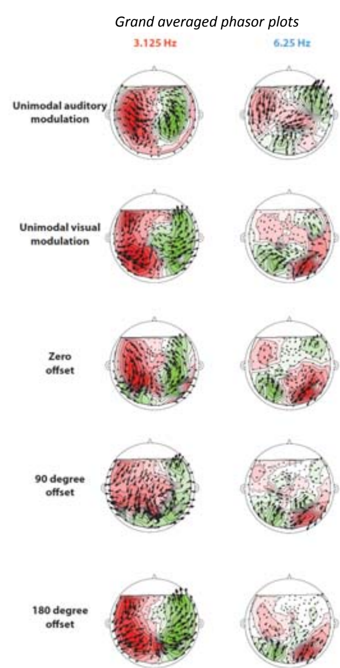
1. **Greatest response in Posterior Temporal & Occipital sensors**
2. **Significant SSR at Fm and 2nd harmonic**
3. **No significant SSR in Anterior Temporal sensors**

Increase in power for A+V SSR in Auditory Sensors



1. **Posterior Temporal sensors power increase for A+V**
2. **No difference in overall power for Occipital sensors**
3. **No difference in overall power for envelope shifts**
4. **SSR power at 3.125 Hz > 6.25 Hz**

Topography may 'index' envelope synchronicity



1. **3.125 Hz: observed topography resembles visual response**
2. **6.25 Hz: observed topography resembles auditory response**
3. **sink-source distribution at 6.25 Hz changes with envelope synchrony: mixed auditory and visual response**
4. **stable sink-source distribution in occipital sensors**

DISCUSSION

1. **Multisensory SSR elicited using novel stimulus types**
2. **A+V modulated stimuli induced greatest response change in auditory sensor areas**
3. **Topographic phasor plots suggest harmonics may reflect differential processing within & across modalities**

▪**No effect of envelope phase shift?**
▪Some asynchrony is tolerated for AV detection and synchronicity judgment [1,2]; onset/offset synchrony may have driven perceptual 'grouping' of A+V in these stimuli

▪**No power increase in visual sensors for bimodal stimuli** [cf. 3]
▪Differences in unimodal control conditions for comparison

▪**Does envelope tracking response scale up to real speech?**
▪Speech envelopes have variable rates, also FM in speech

SELECTED REFERENCES & ACKNOWLEDGMENTS

[1] Grant & Seitz (2000) The use of visible speech cues for improving auditory detection of spoken sentences. J Acoust Soc Am 108:1197–1208 [2] Luo et al. (2010) Auditory cortex tracks both auditory and visual stimulus dynamics using low-frequency neuronal phase modulation. PloS Biol 8(8):e1000445 [3] van Wassenhove et al. (2007) Temporal window of integration in auditory-visual speech perception. Neuropsychologia 45(3):598–607.
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