Amplitude Modulated Noise Negatively Affects Processing of Prosodic Cues

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MOTIVATION

- Acoustic cues used for prosodic phrasing (as realized e.g., by amplitude modulation, pitch contour, rhythm information) can determine the syntactic structure and hence sentence interpretation (e.g., Steinhauer et al., 1999; Frazier et al., 2006).
- Supra-segmental information seems redundant enough to be processed even in loud stationary background noise, which is otherwise detrimental to segmental information (decreased intelligibility, word order effects, Carroll, 2013).
- A noise masker with an amplitude modulated envelope is beneficial for speech recognition (compared to stationary noise) due to ‘glimpsing’ (e.g., Cooke 2006; Wagner et al., 2003). However, modulated noise can be more detrimental on a cognitive level because it is more difficult to “tune out” or segregate (e.g., Francart et al., 2011).
- Does the usability of prosodic phrasing observed for speech recognition in stationary noise (e.g., Carroll, 2013) also hold for an amplitude modulated noise masker? An unpredictable rhythmic disruption may affect processing of rhythmic-prosodic cues (e.g., entrainment, signal segregation mechanisms).

METHOD

- Closure Positive Shift (CPS, Steinhauer et al., 1999) as prosodic ERP component
- 64 Ag/AgCl electrodes (10/20 system)
- Context sentence
- Offline comprehension task: Interpretation/Scope

RESULTS I: COMPREHENSION

- Preference for structure with 2 IPBs over 1 IPB structure

RESULTS II: EVENT-RELATED POTENTIALS

- CPS in All Acoustic Conditions
  - CPS strongest at centro-parietal and midline electrode positions
  - CPS Silence 350 – 750 ms
  - CPS Stationary Noise delayed + extended: 450 – 950 ms
  - CPS Fluctuating Noise delayed + extended 450 – 1000 ms
  - CPS Fluctuating Noise similar amplitude as CPS Silence

DISCUSSION

- Typical processing of prosodic phrasing:
  - Offline error rates: processing preference for 2 over 1 IPBs, but no interaction with noise presentation → Attachment preference, chunking benefit
  - Closure Positive Shift (CPS) clearly observable at IPBs between 350 and 750 ms (450-1000 ms, respectively) post prefinal syllable onset at centro-parietal electrodes

- Differential Effects of Noise Maskers
  - Delay, extension: Signal segregation cost, “listening effort”, comparable to reaction time differences in noise (e.g., Carroll, 2013)
  - Increased amplitude: Additional processing cost associated with reconstruction of segmental information
  - Increased amplitude: Release from masking on segmental level (coarticulatory cues?)

- Differential effects of amplitude modulated noise masking on segmental and suprasegmental cues BUT: No specific evidence for difficulty due to rhythmic competition

REFERENCES