P088

AUDITORY IMPLANTS FOR ADULTS

MRC Cognition and Brain Sciences Unit | NHS | UNIVERSITY OF CAMBRIDGE | Cambridge Hearing Group

Getting More Auditory-Nerve Bang For Your Facial-Nerve Buck: Effects Of Pulse Shape On Loudness And Facial-Nerve Activation In Cochlear-Implant Listeners

John Deeks[1], Dorothée Arzounian[1], Manohar Bance[2], and Robert Carlyon[1]

[1]MRC Cognition and Brain Sciences Unit, University of Cambridge, UK. [2]Dept. of Clinical Neurosciences, University of Cambridge, UK

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Introduction

- Facial-nerve (FN) activation by cochlear-implant (CI) electrodes can require those electrodes to be turned off, thereby impairing speech perception
- We investigated the effects of two manipulations – increased phase duration and asymmetric pulses – that have been proposed to reduce FN stimulation (FNS)
- We also obtain loudness reports including the Most Comfortable Level (MCL), so as to calculate the Facial-Auditory Nerve Gap ("FANG") for each pulse type

  FANG = FNS threshold - auditory MCL
- The project builds on previous studies showing that MCLs are lower for anodic-dominant than for cathodic-dominant asymmetric pulses, with the opposite effect observed for FN thresholds

Research Questons:

1. ***Can pulse polarity increase FANG?***

Separate evidence from different studies suggest that polarity has opposite effects on loudness and on FN threshold:

- ***Loudness:*** MCLs approx. 2 dB lower for anodic than for cathodic stimulation
- ***FN thresholds:*** lower (and responses higher) for cathodic than for anodic stimulation

2. ***Do symmetric pulses improve FANG compared to symmetric pulses?***
3. ***Does increasing phase duration increase FANG?***

Exp. 1 – Low-rate unmodulated pulses

- **FNS group** – 2 Medel users who experience FNS in daily CI use
- **non-FNS group** – 2 Cochlear users without any FNS experience, but whom exhibited myogenic responses with stimuli delivered to an electrode used in previous EEG experiments
- Loudness growth and FNS report – 500-ms 40-pps pulse trains delivered in MP to a single apical electrode
- EEG used to measure myogenic response as a function of input level (8-channel BioSemi, 600 sweeps, electrodes place above\below eyes and lips)
- Pulse shapes are shown in Fig.1:

  Symmetric pulses with either anodic- or cathodic-leading phase, and with either 32 or 150 us phase duration (SYM –A\C -32\150) – used by both Medel and Cochlear users

  Asymmetric pulses were either quadraphasic (Cochlear, QP) or triphasic (Medel, TP) with middle-phase either anodic or cathodic. Middle-phase duration: TP =150 us, QP = 64 to 150 us

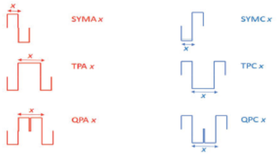
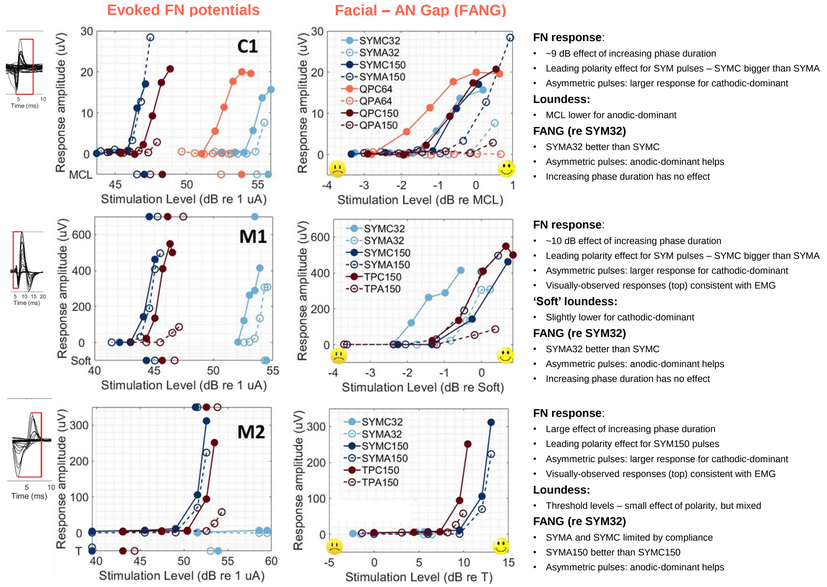


Fig.1. Pulse shapes used in Exp.1 and 2., where x is the duration of the effective phases.

Exp.1 - Results

- For M1 and M2, maximum loudness often limited to 'Soft' levels due to FNS
- Fig. 2 shows evoked FN response as a function of stimulus level (left panels), and referenced to loudness (MCL for C1, 'Soft' and Threshold for M1 and M2 respect.)



Exp.2 - Conclusions

FN Response:

- Large effect of increasing phase duration
- Symmetric pulses: reduced response with anodic vs cathodic leading polarity
- Asymmetric pulses: larger responses for cathodic-dominant
- Visually-observed responses consistent with EMG

Loudness Growth:

- C1 and C2: MCL lower for anodic-dominant
- M1 and M2 could not reach MCL. Polarity effect less consistent at lower sensation levels

FANG (re: SYM32):

- SYMA32 gives smaller FN response than SYMC32 for both M1 ad M2
- TPA gives smaller FN response than TPC for both M1 ad M2
- Increasing phase duration helps for M1

Exp. 2 – High-rate unmodulated and AM pulses

- Previous measures of FN response (like those used here) used very slow pulse rates
- Our measures show a polarity effect for both symmetric and asymmetric pulses. Do these effects disappear with high pulse rates?
- **Exp.2a** used 2-ms bursts (rate = 2000-pps) of 6 pulses in attempt to measure FN response with stimuli closer to clinical settings
- Pulse shapes were SYM at 32 and 150 us, and TP pulses at 150 us. TPC150 Single-Pulse used to check if FN dominated by 1st pulse, and link to previous measures

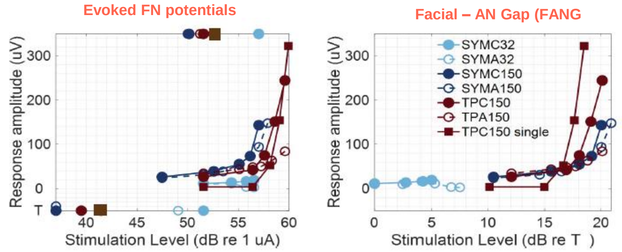


Fig.3. High-rate burst FN and FANG data from M2

- Fig. 3 shows FN curve shifts by around 2 dB with 6-pulse TPC150 vs TPC Single
- Polarity effect persists for both symmetric and asymmetric pulses
- **Exp.2b** measured FN responses to AM pulse trains with rates 25 to 55 Hz, using carrier rates around 500-pps. Pulse shapes were SYMC150 and TPA\C150
- Fig. 4 (left) shows the fundamental (F0) component of the steady-state response to AM stimuli, measured from subject M1. F0 amplitude is shown as a function of stimulus level (re: 'Soft'), AM = 55 Hz. Group delays (right) were obtained from F0 phase variations with AM rate and provide an estimate of response latency (rules out artefact)
- Polarity effect smaller and reversed. AM tests with other FNS patients continue

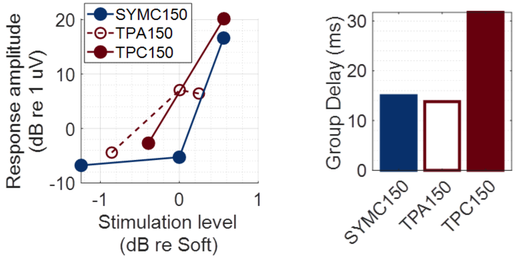


Fig.4. EFSSR F0 growth functions (left panel) for each pulse shape together with Group Delay (right panel), subject M1

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