# Journal Club 11/4/20

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# Bilateral Bone-Anchored Hearing Aids (BAHAs): An Audiometric Evaluation

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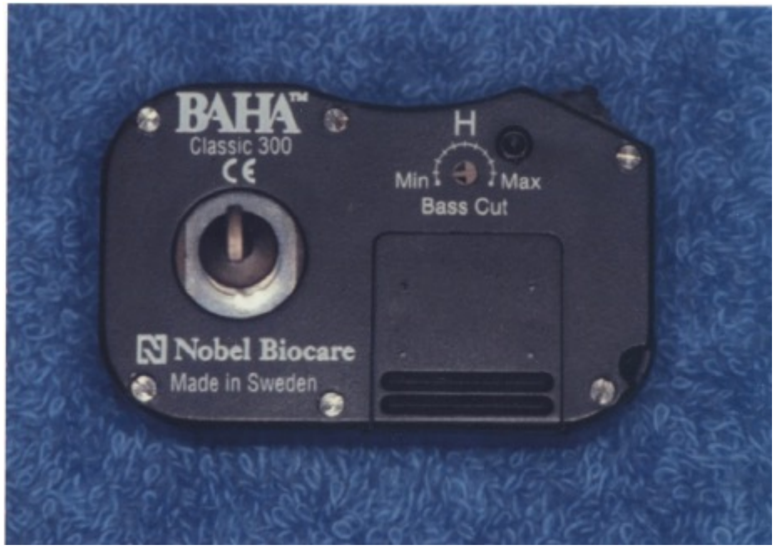
# Study Rationale and Background

- BAHAs are being used for patients with conductive and mixed hearing loss
- Patients with symmetric hearing loss prefer bilateral amplification with hearing aids
- Patients in the study wearing bilateral BAHAs reported subjectively better hearing with 2 devices (better sound quality and directional hearing), and commonly wore both

- Is there objective hearing improvement with bilateral BAHAs?

>Based on directional hearing, speech perception in quiet and noise and BMLD (binaural masking difference test)

# C300 and Compact BAHAs are directly vibrating bone





# Bilateral BAHAs

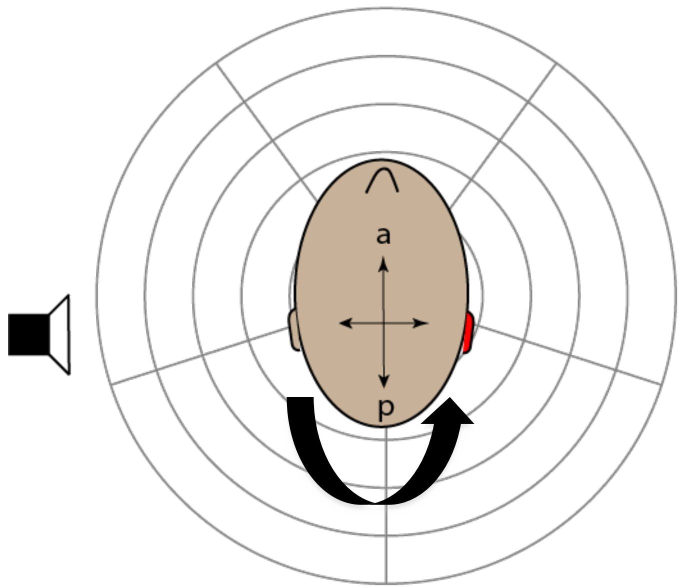
- Measurements of bone conduction sound transmission > difference in sound transmission from from one BAHA to each cochlea is less than 15dB (esp. lower frequencies)

- Are bilateral BAHAs truly improving binaural hearing or this just an effect of greater overall stimulation level through two amplifiers?

- Effect categories:
  > Improved hearing thresholds
  > Directional hearing
  > Binaural hearing

# Bilateral BAHAs

Head shadow effect




- Directional hearing: Ability to localize the spatial direction of sound
- Binaural hearing: Ability to use binaural cues (use the different sound information at the two cochleae to improve hearing)
- Head-shadow effect: Sound presented to poor hearing ear has to pass through the head to get to other side, which attenuates speech intensity

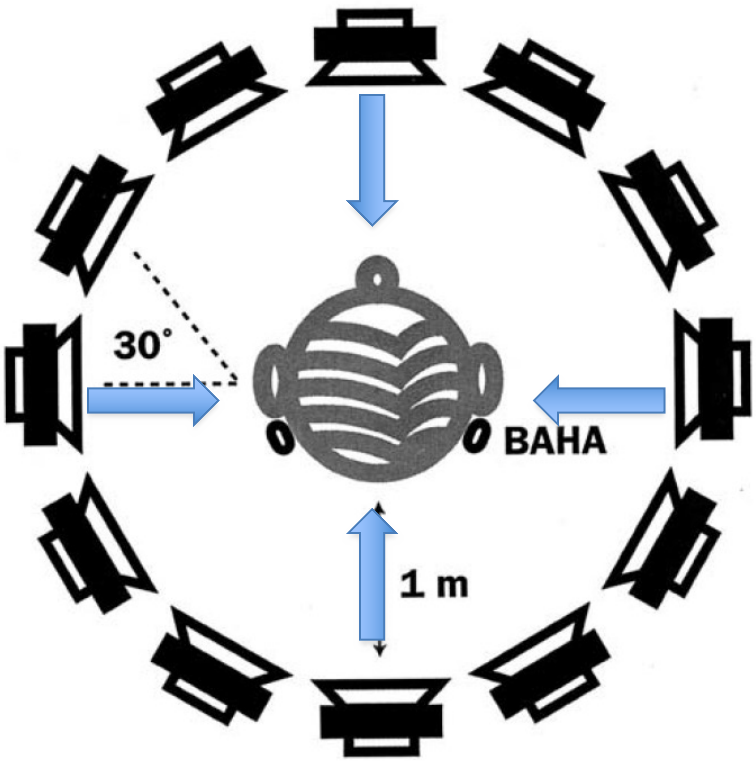
# Study population – Table 1

- 12 adult patients with bilateral BAHAs (> 1 year), 11/12 with daily use
- 9/12 with mixed HL, 3/12 with CHL
- 10/12 with symmetric SNHL (< 10 dB difference at 0.5, 1, 2 and 4 kHz)
- 2/12 with asymmetric SNHL (< 20 dB)

TABLE I.
Characteristics of the 12 Included Patients.

| | | | | | | | | | BAHA Experience | | First Side | | Second Side | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number | Sex | Age (years) | Type of BAHA Left | Type of BAHA Right | Abutment Left | Abutment Right | First Fitted Side | Subjective Best Side | Uni (years) | Bil (years) | AC (dB HLac) | BC (dB HLbc) | AC (dB HLac) | BC (dB HLbc) | Etiology |
| 1 | M | 42 | Comp | Comp | S | S | L | R | 14.0 | 6.7 | 55 | 17 | 27 | 20 | CO |
| 2 | F | 68 | C300 | C300 | B | B | R | R | 17.5 | 15.1 | 87 | 52* | 102 | 45 | CO |
| 3 | F | 55 | C300 | C300 | B | B | L | L | 15.4 | 8.6 | 48 | 18 | 53 | 27 | CO |
| 4 | F | 60 | C300 | C300 | B | B | R | R | 10.4 | 2.6 | 55 | 35 | 62 | 33 | CO |
| 5 | M | 58 | Comp | Comp | S | S | R | R | 16.6 | 3.0 | 82 | 53 | 70 | 50 | CO |
| 6 | F | 65 | C300 | Comp | B | S | R | R | 16.9 | 2.9 | 73 | 43 | 68 | 43 | CO |
| 7 | F | 65 | C300 | C300 | S | S | L | L | 10.7 | 9.7 | 50 | 28* | 77 | 47 | CO |
| 8 | F | 51 | Comp | Comp | S | S | R | L | 5.8 | 1.0 | 62 | 40 | 28 | 25 | EO |
| 9 | F | 47 | C300 | C300 | S | S | L | L | 10.9 | 1.4 | 42 | 27 | 58 | 27 | CO |
| 10 | F | 52 | C300 | C300 | B | S | L | R | 21.0 | 19.6 | 58 | 27* | 67 | 32 | CA |
| 11 | F | 27 | C300 | C300 | S | S | R | R | 15.2 | 1.0 | 50 | 10 | 48 | 7 | CA |
| 12 | M | 30 | Comp | Comp | B | S | R | R | 17.0 | 10.1 | 38 | 8 | 48 | 15 | CA |

# Study test setup: Free Soundfield – Figure 1



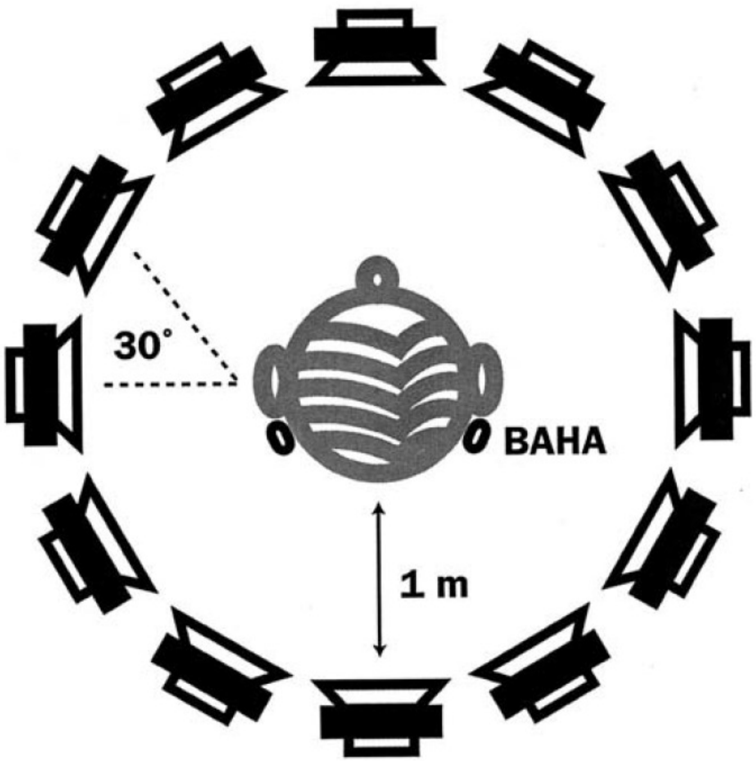

- 12 speakers, 30˚ intervals
- Free soundfield tone thresholds were tested from 4 directions
- 3 conditions:

  > unilateral (better) BAHA

  > unilateral BAHA (shadow side)

  > bilateral BAHAs

# Study test setup: Directional hearing



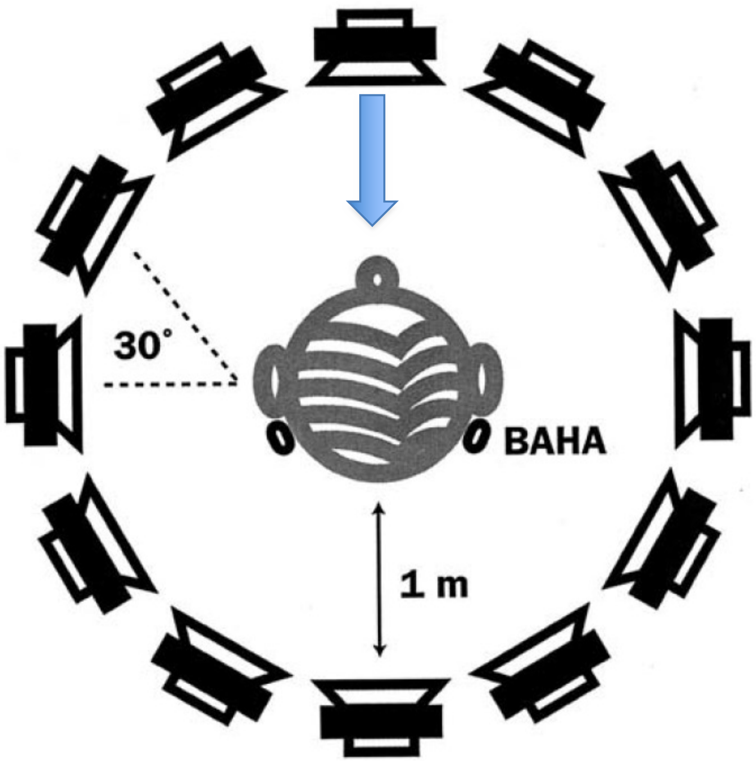

- 12 speakers, 30˚ intervals
- Narrow-band noise at 0.5 or 2 kHz at 65 dB HL for 1 s
- 3 conditions:

    > unilateral (better) BAHA

    > unilateral BAHA (shadow side)

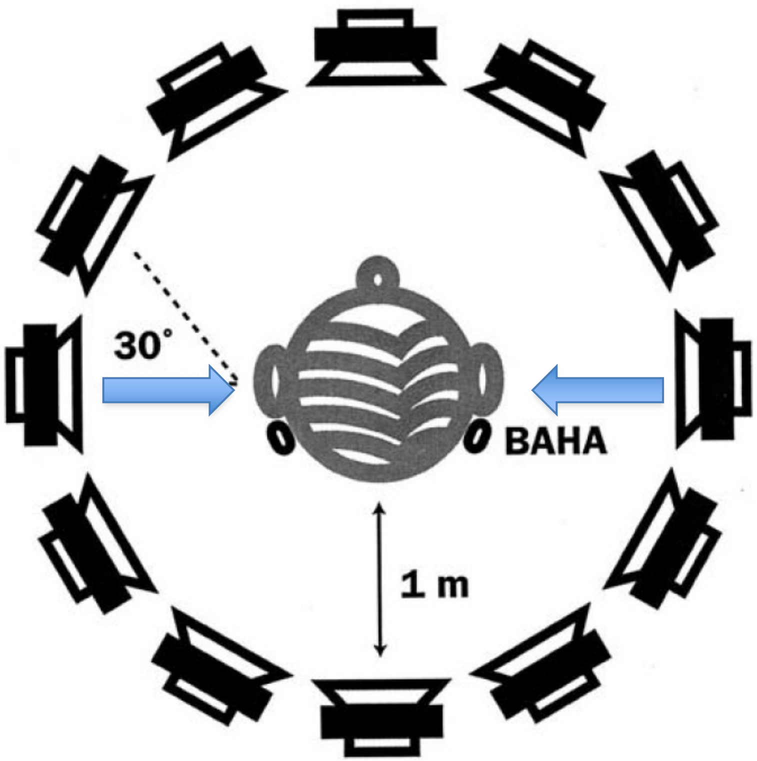
    > bilateral BAHAs
- Repeated x3 from each speaker (total 12 directions)

# Study test setup: Speech perception threshold



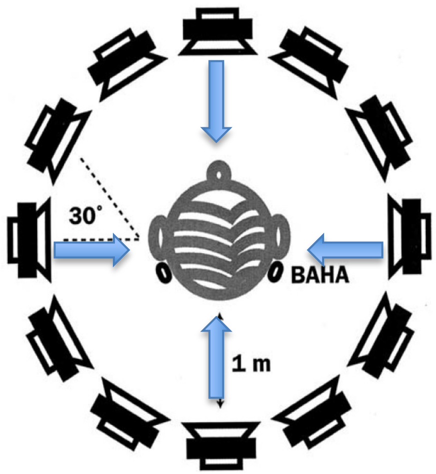

- Three- word sentences at 0˚ ( 3 lists with 10 sentences)
- In quiet and noise (65-80 dB HL)
- Noise was presented from either left or right or all speakers (surrounding noise)
- 2 conditions:
  - > unilateral (better) BAHA
  - > bilateral BAHAs
- Repeated x2

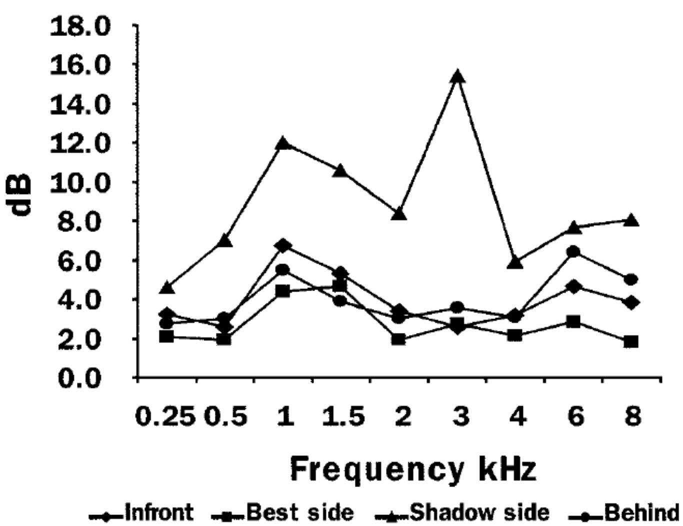
# Study test setup: Binaural Masking Level Difference (BMLD) Test




- Tests true binaural hearing
- Tested with bilateral BAHAs
- Pure tone presented in noise
- 3 conditions:
  - > Tone and noise presented equally to both sides
  - > Tones out of phase (180˚) on both sides, but noise levels the same
  - > Noise at both sides out of phase (180˚), but tones in phase
- Sound directly supplied to BAHA transducer, no microphone
- 0.25, 0.5 and 1 kHz, at 65 dB HL, x2 repeats

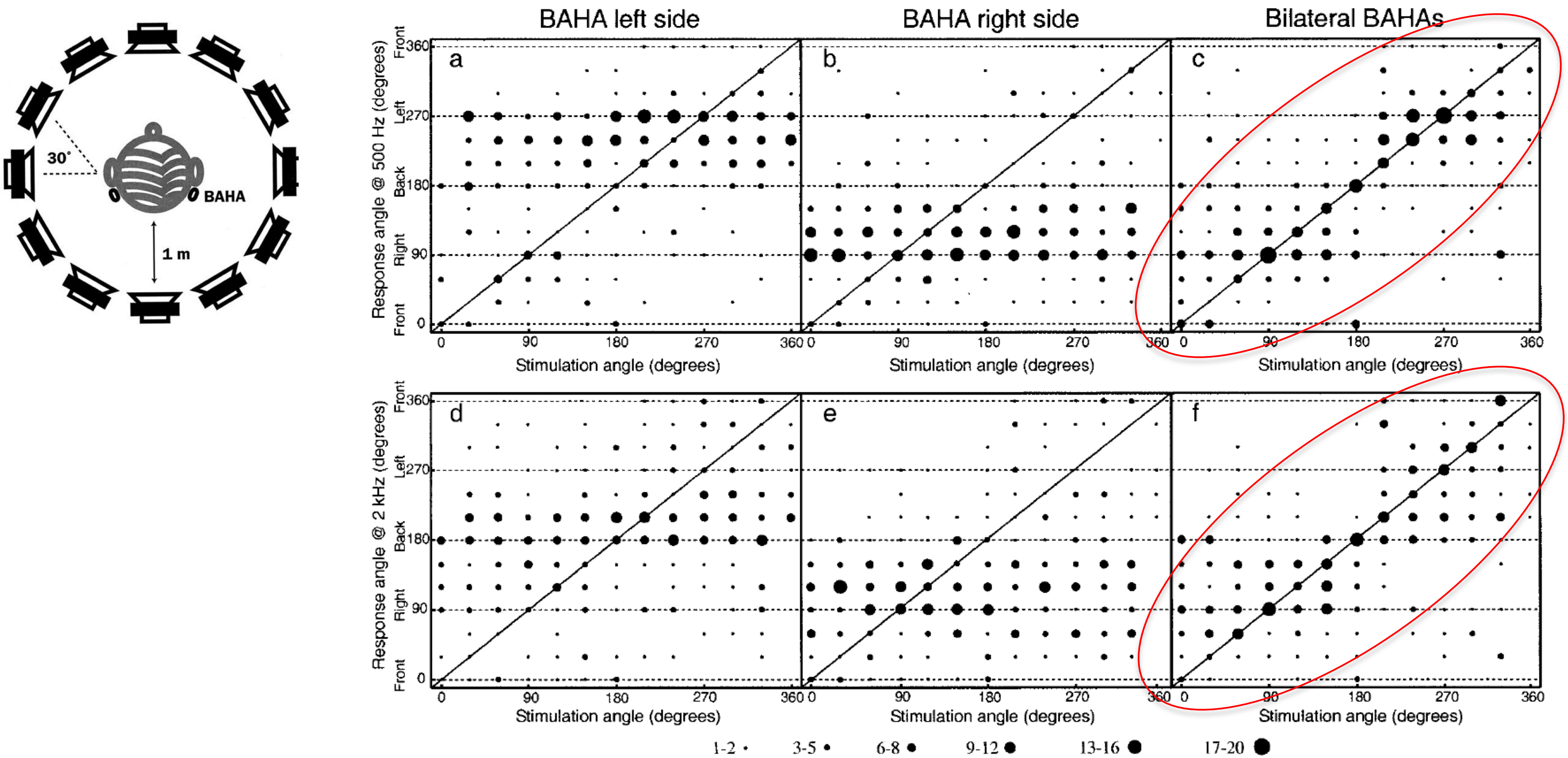
# Results: Free Soundfield – Figure 2



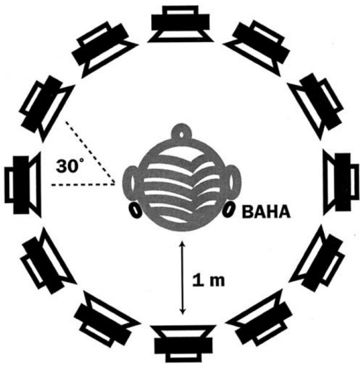

- Unilateral vs bilateral BAHA fitting
- Average improvement with bilateral fitting ~2-7 dB
- Greater when presented on shadow side with bilateral fitting: ~5-15 dB, as head-shadow effect is minimized (but: highest SD)
- Great variability, no significance

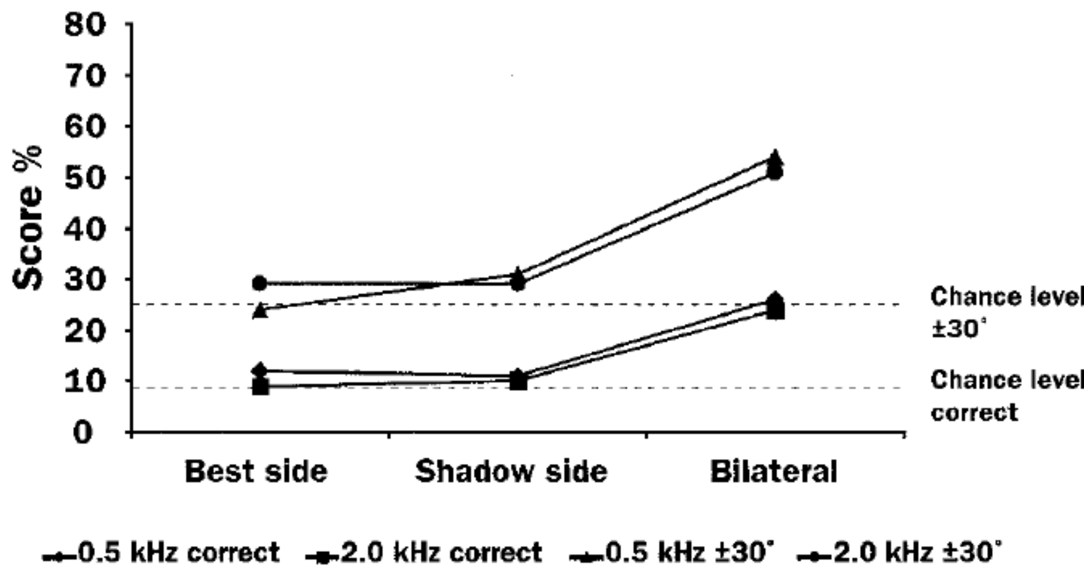
# Results: Directional Hearing – Figure 3




- Patients ability to locate sound source
- Larger circle = more responses, correct responses along diagonal line

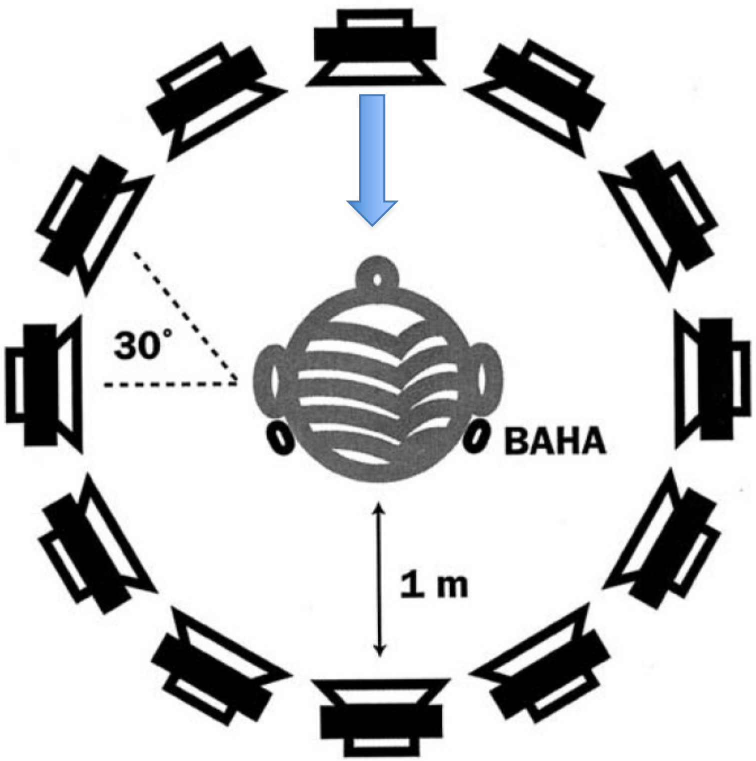
# Results: Directional Hearing – Figure 4



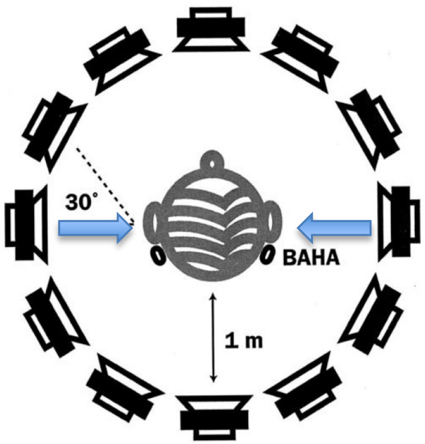

- Results presented as correct score or whether within 30˚ of stimulation at 0.5 and 2 kHz.
- Unilateral BAHA sides are similar, and close to chance (8.5% correct, and 25% within 30˚)
- Bilateral BAHA increases ability to locate sound correctly (Significance??)

# Results: Speech perception threshold

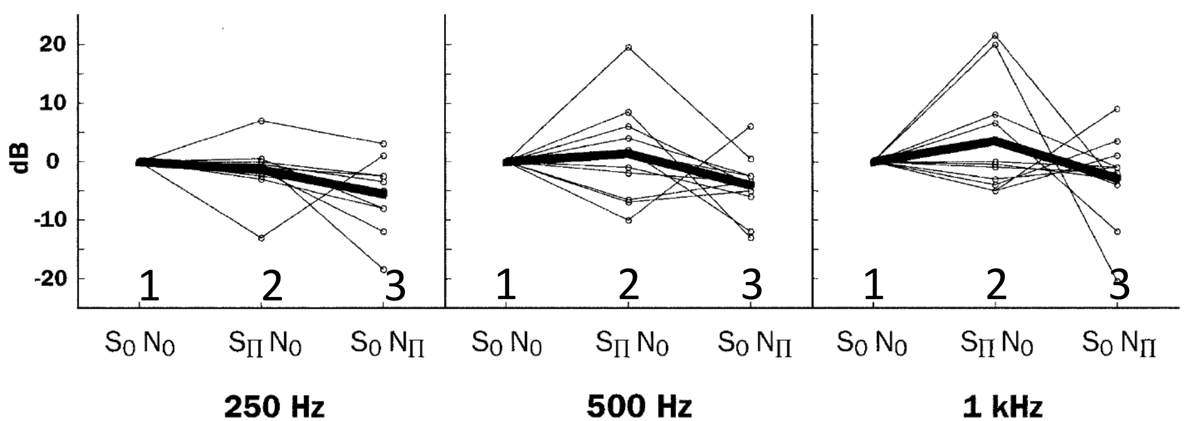



- Average threshold in quiet:
  - Unilateral BAHA: 38.7 dB HL
  - Bilateral BAHA: 33.3 dB HL
- **Significant improvement of 5.4 dB (P= .001).**
- Speech perception in noise:
  - Noise on better side: 3.1 dB SNR improvement in bilateral BAHAs vs unilateral
  - Noise on shadow side: 1 dB SNR decrease in bilateral BAHAs vs unilateral
  - Surrounding noise: 2.8 dB SNR improvement in bilateral BAHAs vs unilateral
- No significant improvement of speech perception in noise with bilateral BAHAs

# Results: Binaural Masking Level Difference (BMLD) – Figure 5




- At 250 Hz, changes for different conditions within 3 dB, (2 patients -18dB to 3 dB, average -5 dB)
- At 0.5 and 1 kHz, threshold changed for 2) and 3) between -10 dB to 10 dB for most patients:
  - 0.5 kHz: 2 dB for 2); -4 dB for 3)
  - 1 kHz: 3 dB for 2); -3 dB for 3)




1) Tone and noise presented equally to both sides
2) Tones out of phase (180˚) on both sides, but noise levels the same
3) Noise at both sides out of phase (180˚), but tones in phase

# Discussion points

- Results overlap with prior studies: Slight, significant improvement in speech perception in quiet, and trend towards improvement in directional hearing and BMLD.

- Different testing setup may explain slightly lower scores for directional hearing

- Speech perception in noise only increased by 2.8 dB> deactivation of one BAHA in directed noise

- Patients with CHL did better than patients with mixed HL> SNHL may be limiting factor to bilateral BAHA benefit