Speech recognition with frequency transposition - Part II

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Effect of start frequency on speech recognition in frequency transposition

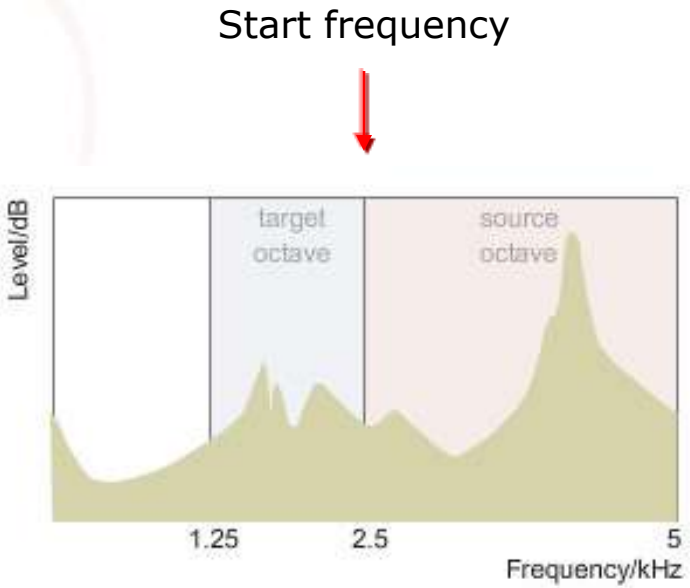
Individual differences

- We showed (Part I) that linear frequency transposition does improve speech identification performance in quiet.

- Previous studies have shown correlation between hearing loss and use and benefit of the transposition program:
    - Adult subjects with more hearing loss at 4 kHz used the AE program more frequently (Kuk et al., 2007).
    - Children with more hearing loss in the low-to-mid frequencies reported greater benefit with transposition (Auriemmo et al., 2008).

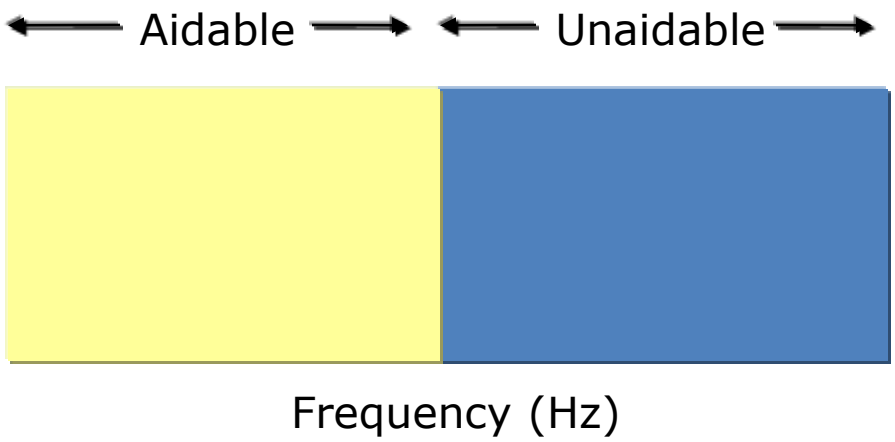
- Would this be the case for this group of subjects?
- Can we expect everyone to perform similarly?

Linear frequency transposition and start frequency

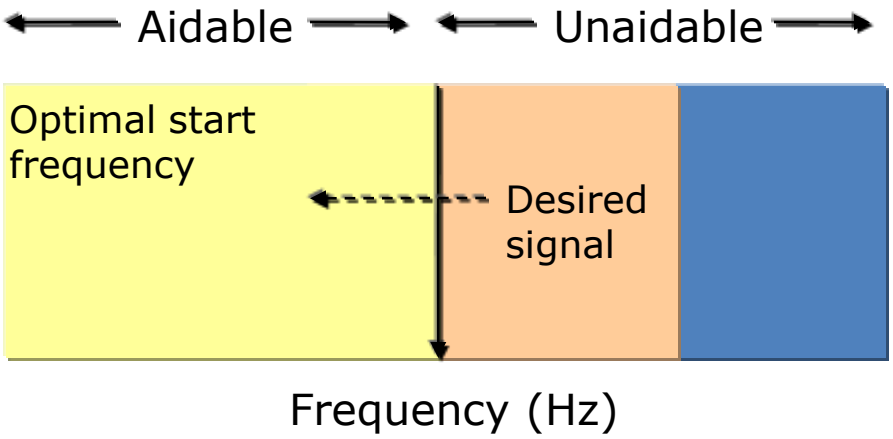


- Start frequency is the cutoff frequency that defines the location of the target and source regions.
- The selection of the start frequency is always carried out based on the characteristics of the individual hearing loss.
- Selection of start frequency essential in ensuring the effect of frequency transposition. Selecting a wrong start frequency may compromise the effect of frequency transposition.

Potential start frequencies

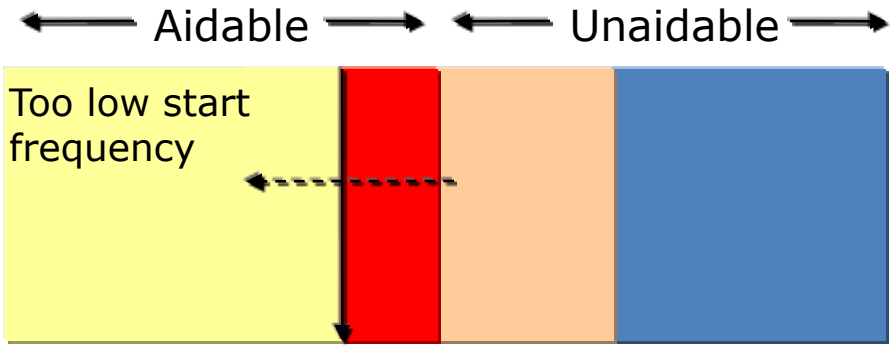


Optimal start frequency



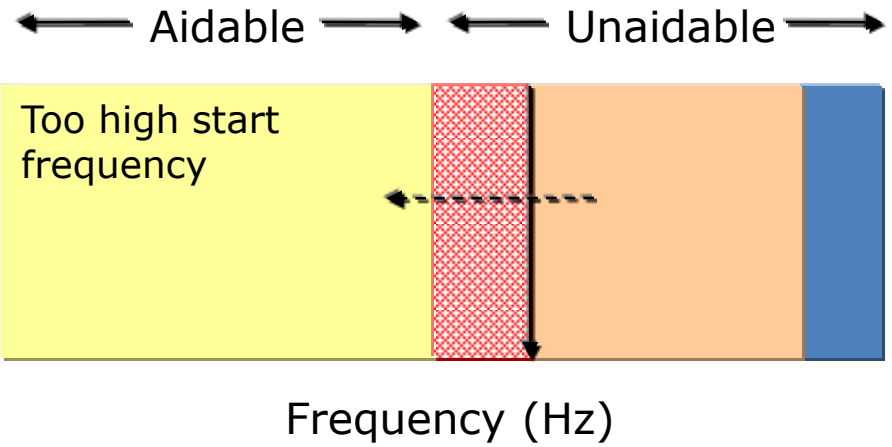
- Optimal start frequency:
  - Aidable frequency region is completely amplified.
  - Only the "unaidable" region is transposed.

Start frequency lower than optimal



- Consequences of lower than optimal start frequency
  - Sounds which could be amplified are lowered.
  - The source region does not extend to as high in frequency as in optimal case.

Start frequency higher than optimal



- Consequences of lower than optimal start frequency
  - Region immediately above start frequency, which is considered unaidable and should have been transposed, is not transposed.
  - The source region now extends to higher frequencies, but these highest sounds will be transposed to a region where the sounds are not aidable even after lowering.

Start frequency and hearing loss

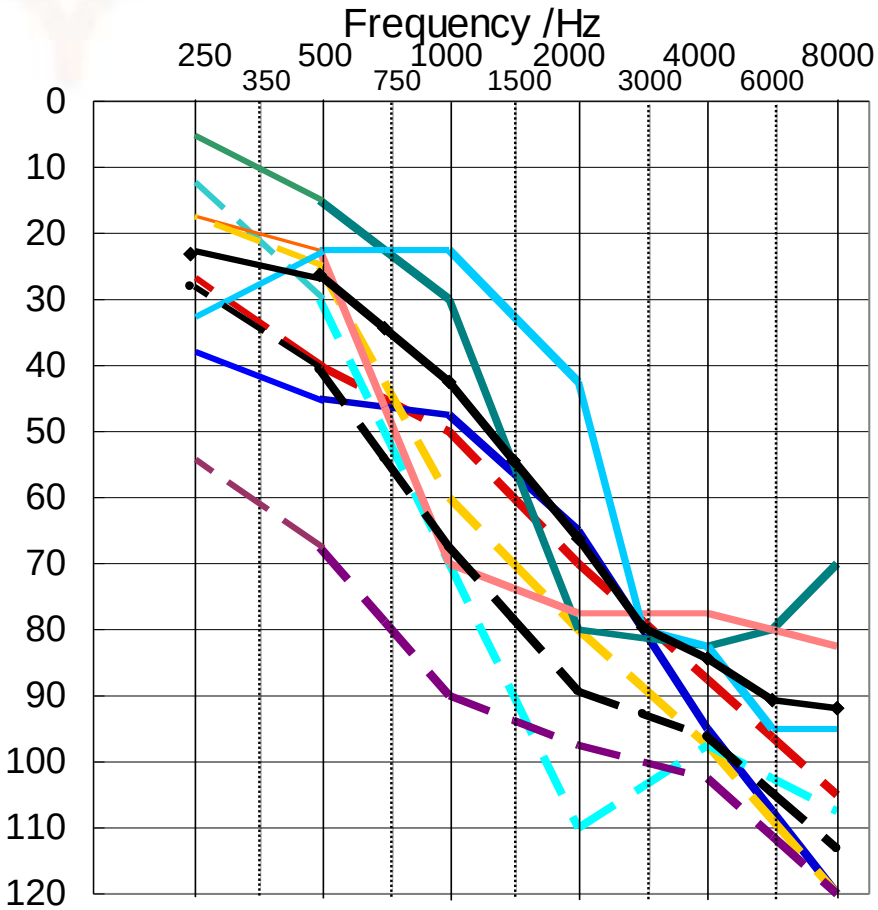
- Optimal selection of start frequency depends on the characteristics of an individual hearing loss.
- People with more restricted hearing are more likely to have lower start frequency.
- We shall use start frequency as a criterion to group the 8 subjects for further analysis of the data from the Part I.

Subjects

- For the analysis the data (8 subjects) divided into two groups (4 subjects each) for analysis based on their start frequencies.

Group < 2.5 kHz			Group 3.2 kHz		
	Start frequency	AE gain		Start frequency	AE gain
S1	2500	0	S5	3200	6
S2	2000	10	S6	3200	0
S3	2000	0	S7	3200	0
S4	2000	8	S8	3200	4

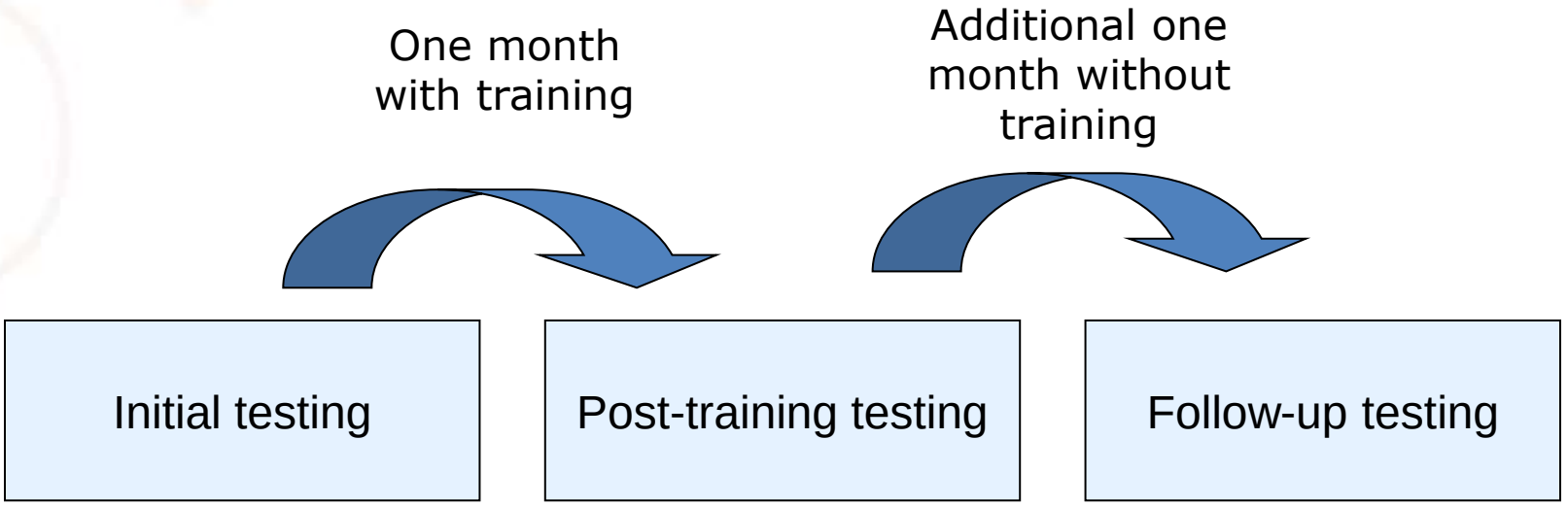
Insert earphone thresholds



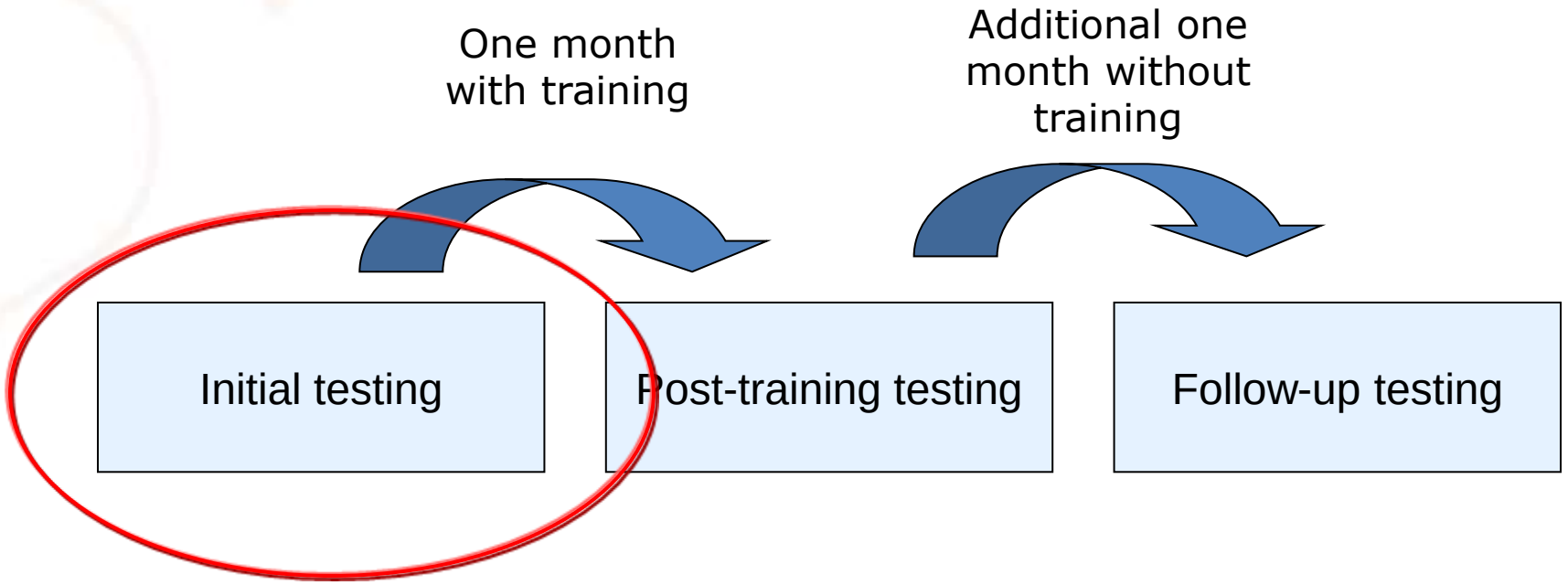
Group 3.2 kHz

Group <2.5 kHz

Timeline


One month with training
Additional one month without training
Initial testing
Post-training testing
Follow-up testing

RESULTS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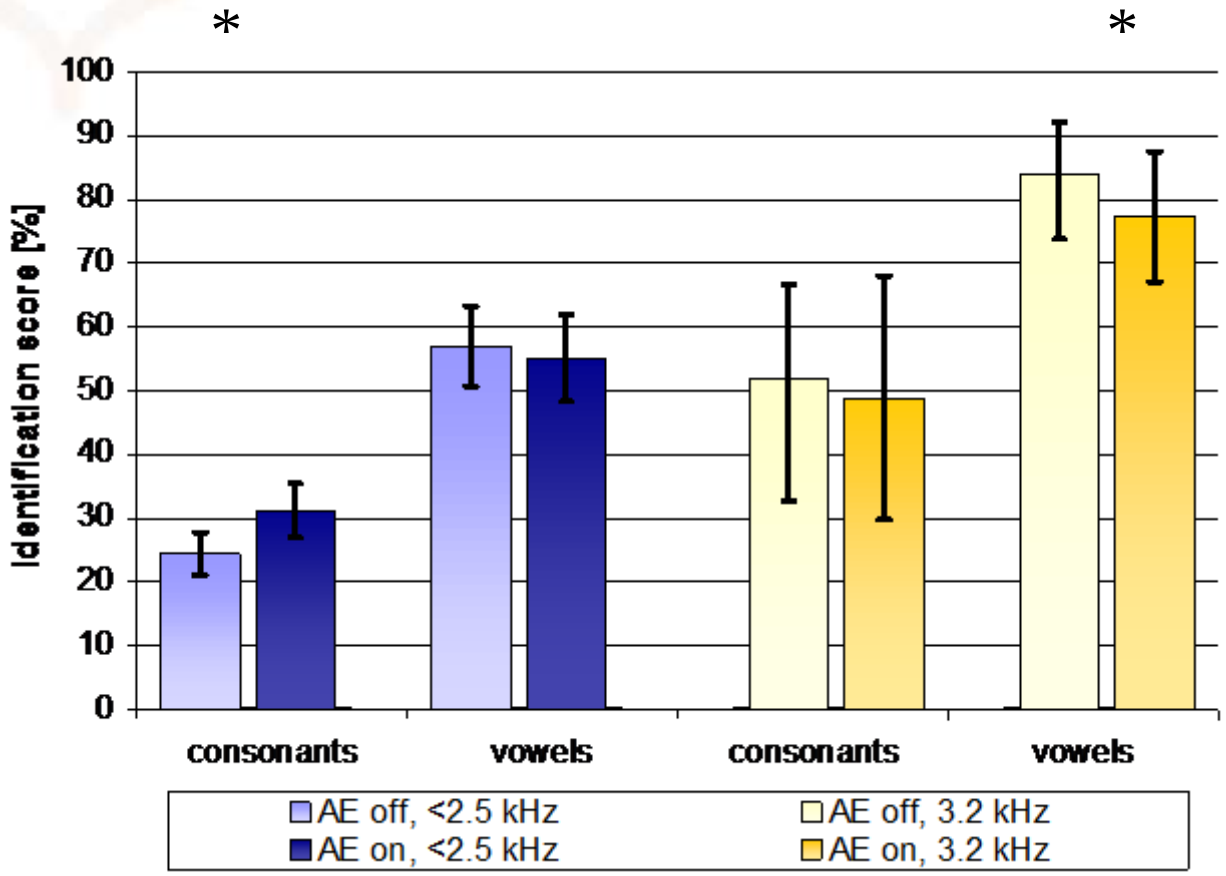
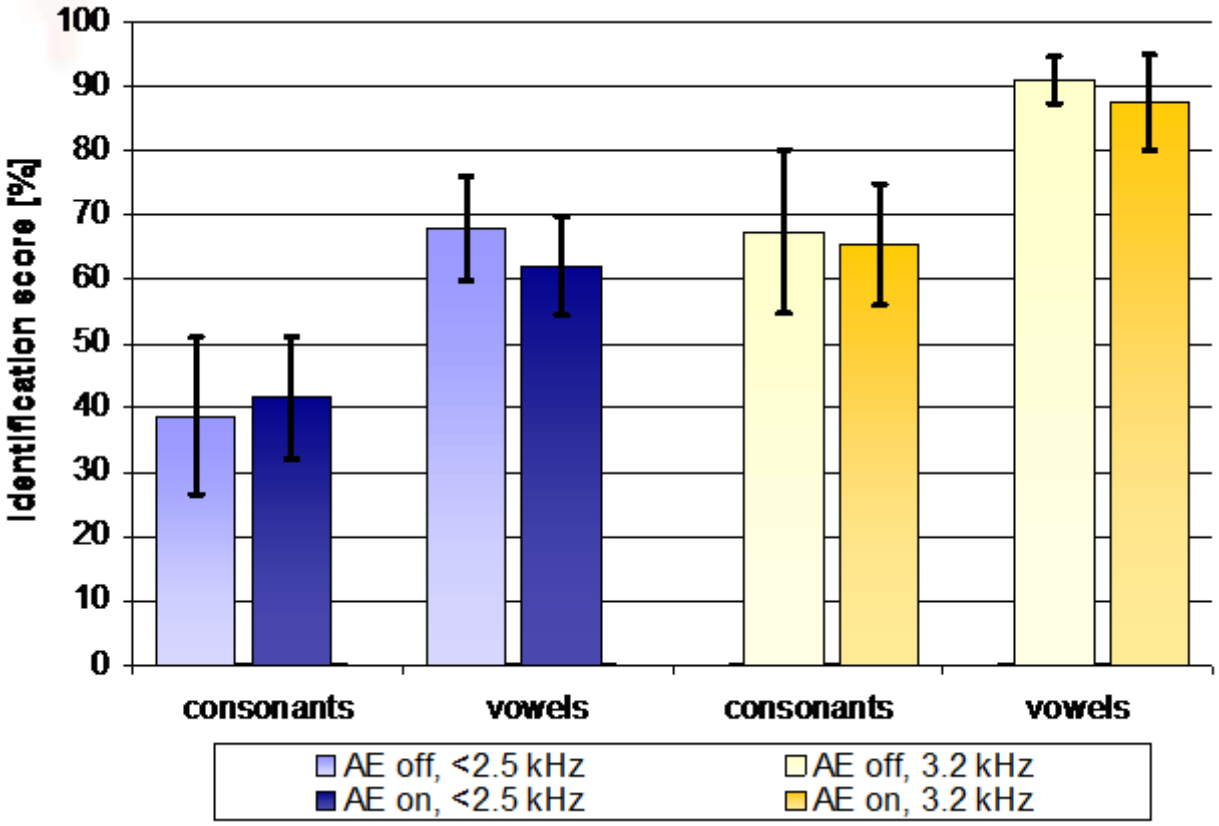
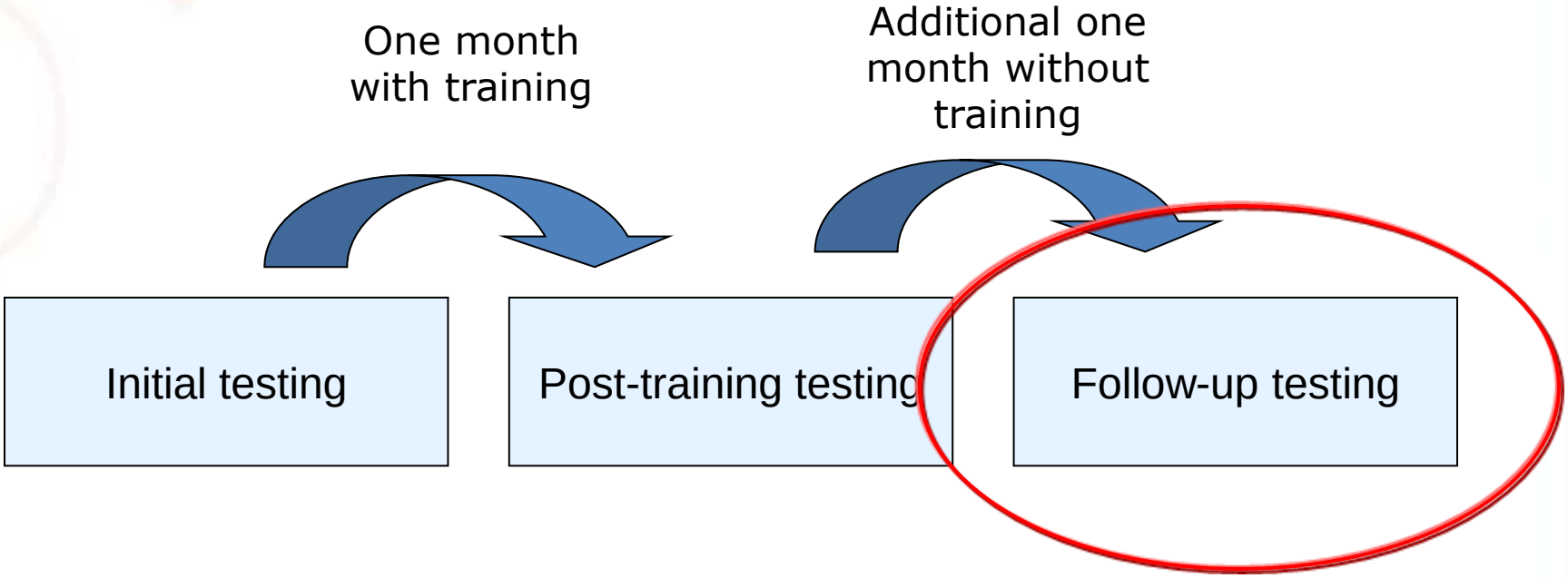
Pre-training (50 dB SPL)



Pre-training (68 dB SPL)

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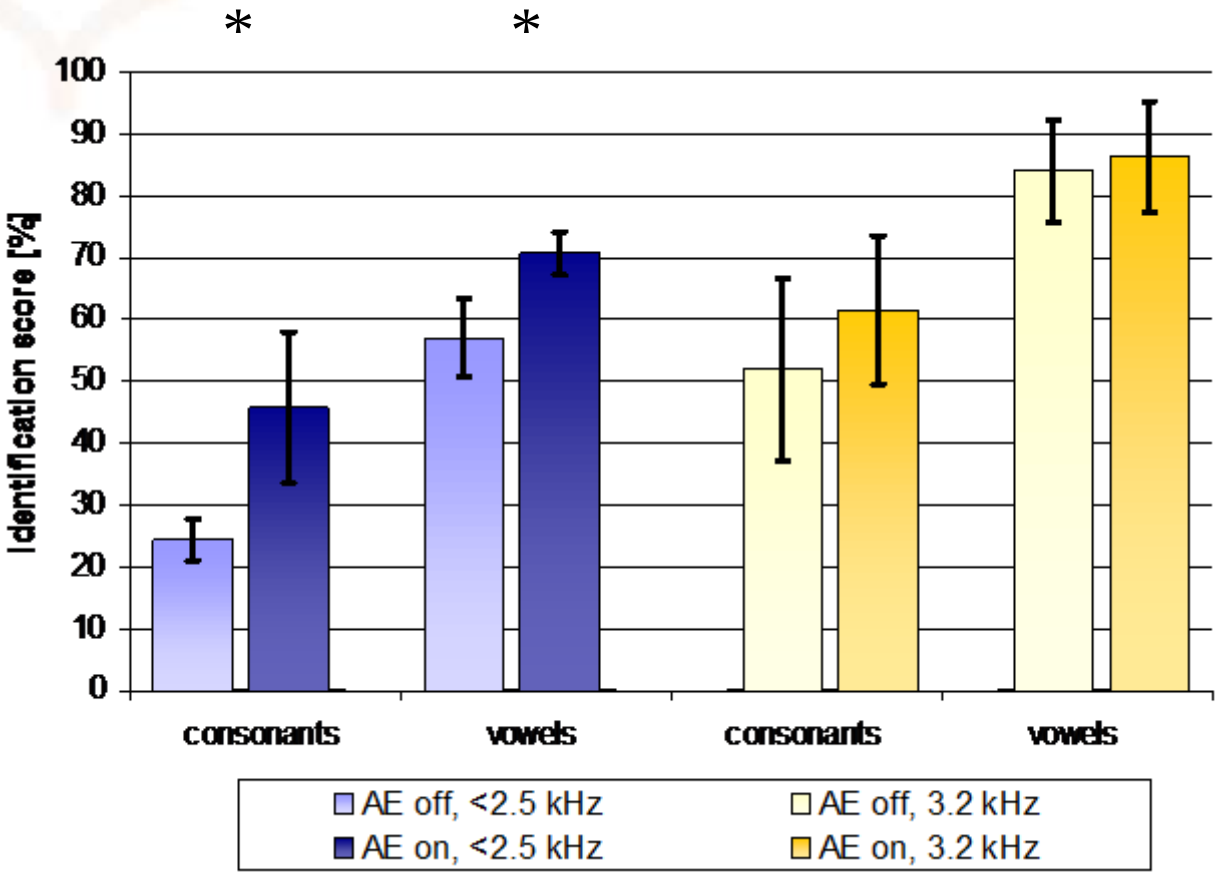
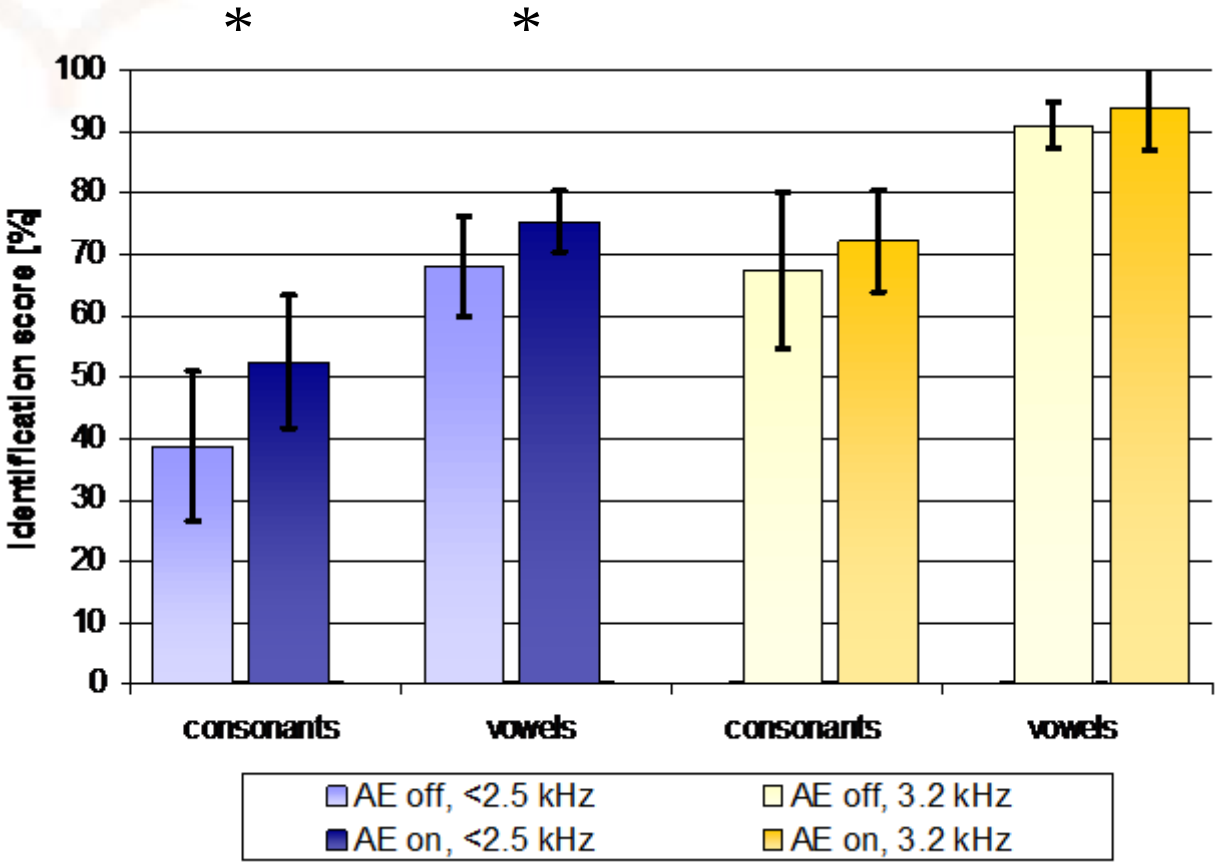
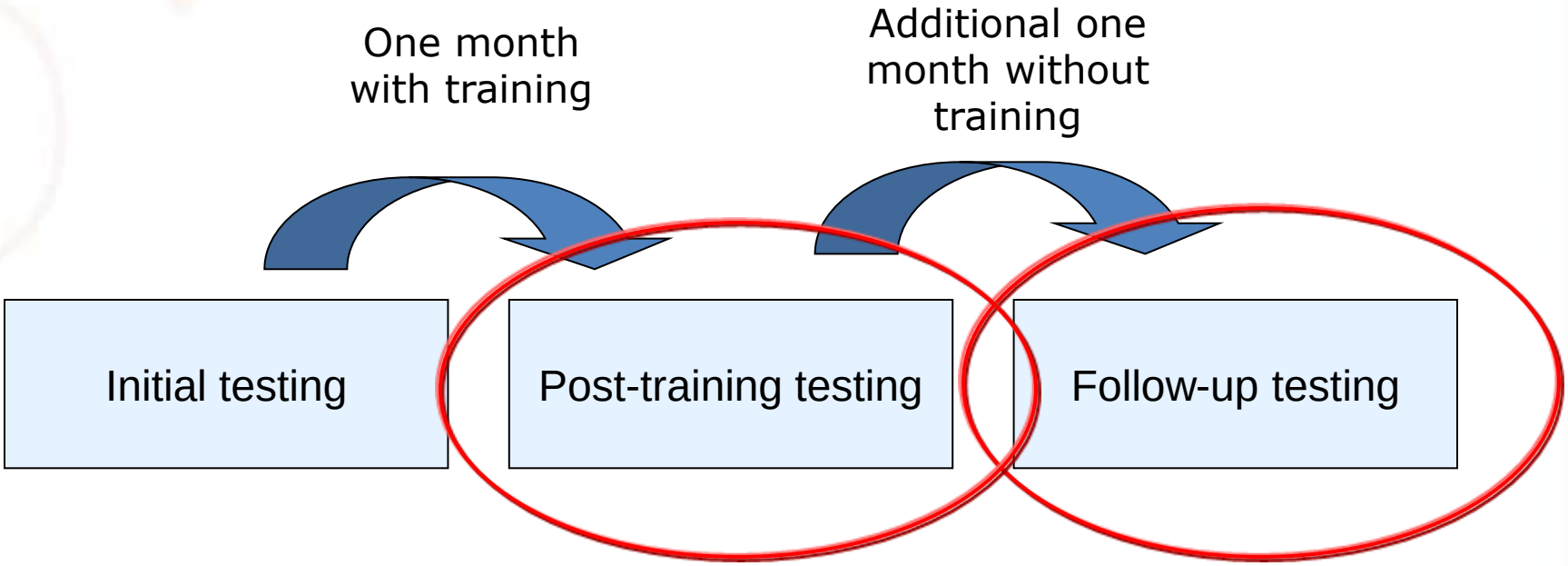
After two months (50 dB SPL)



After two months (68 dB SPL)

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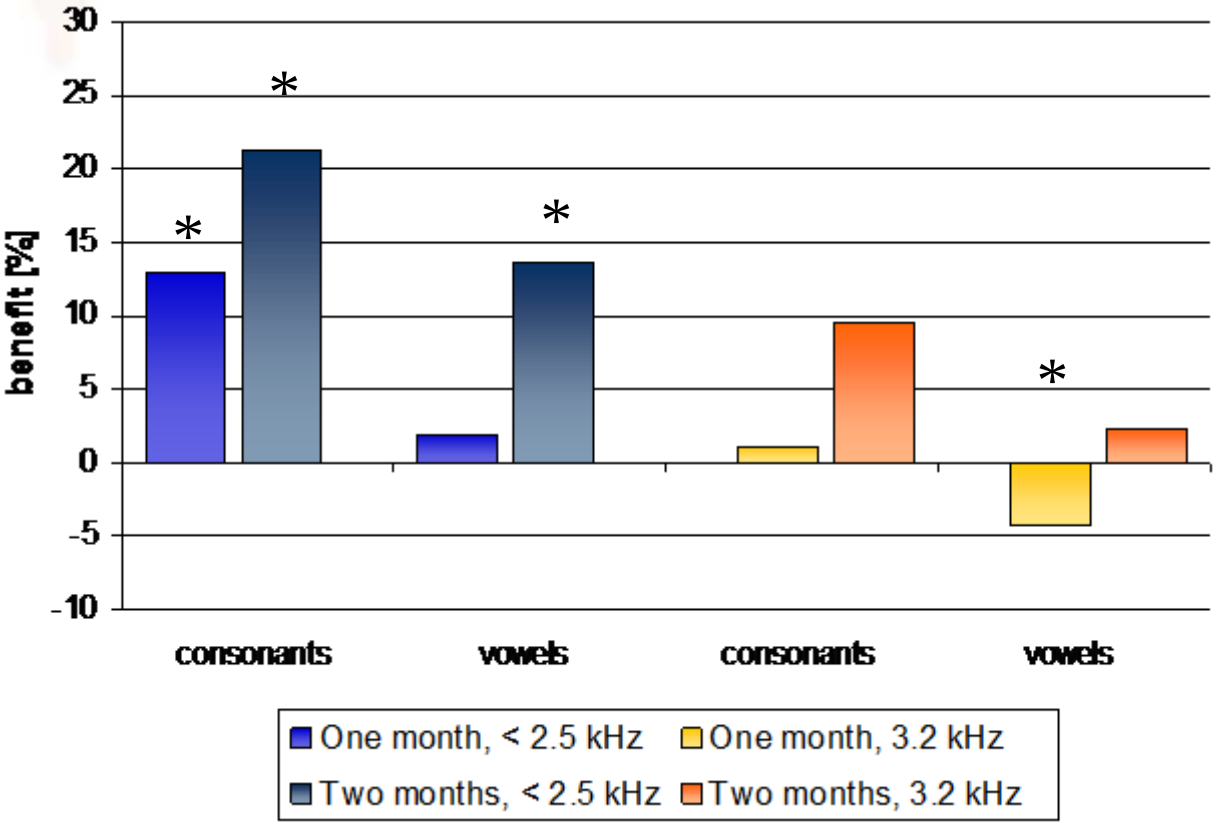
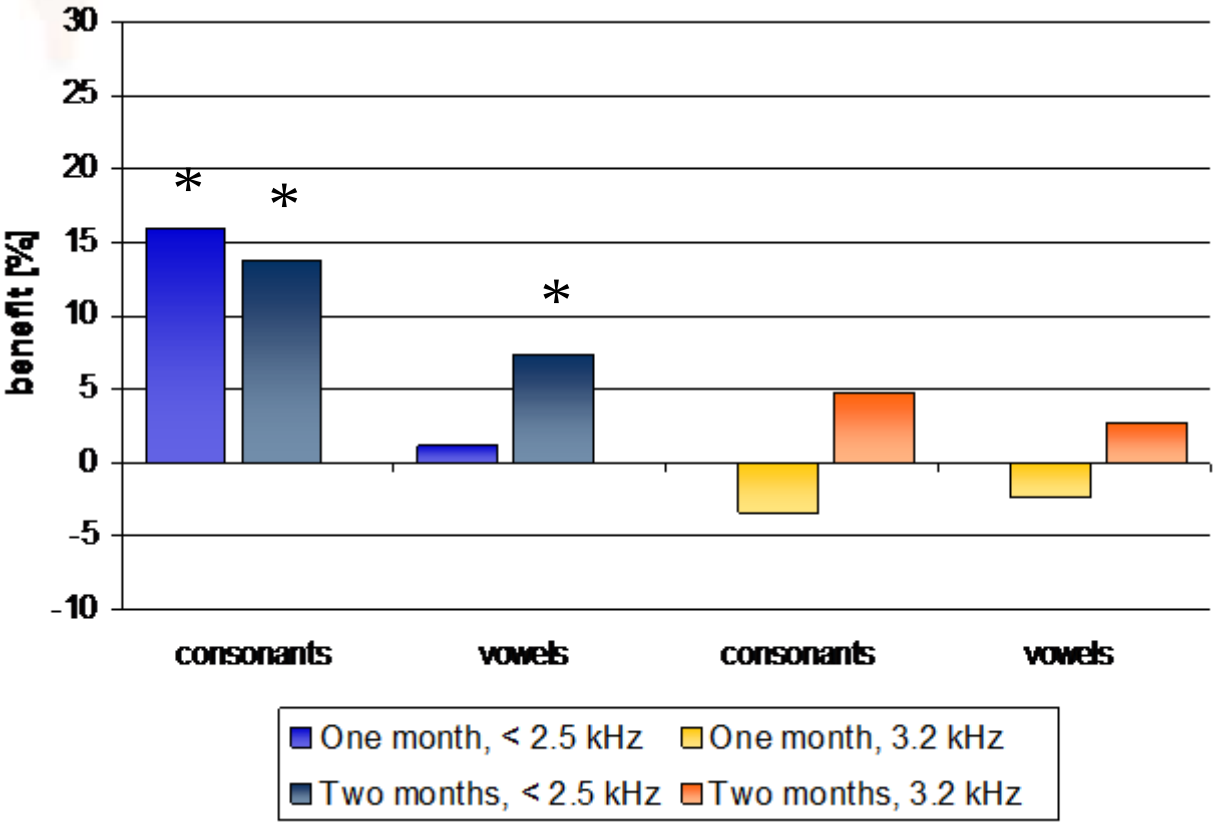
AE benefit after one and two months (50 dB)



AE benefit after one and two months (68 dB SPL)



Benefit for individual phonemes

Consonants with more than 20 % improvement with frequency transposition compared to initial testing with conventional amplification.

	<2.5 kHz group	3.2 kHz group
50 dB SPL	ʃ, g, ʒ, wh, s, t, n, r, z, ʧ, ʤ, h, v, l	ʒ, ʃ, wh, b, ʤ, ð
68 dB SPL	ʃ, ʒ, wh, z, s, g, l	ʒ, ʧ, d, wh

Conclusions

- People with more restricted hearing typically have a lower optimal start frequency.
- The extent of the hearing loss in the high frequencies has an influence in predicting the magnitude of benefit of frequency transposition.

- Greater benefit was observed with soft level than with conversational level.
- Greater benefit was observed with consonants than with vowels.

References

Auriemmo J, Thiele N, Marshall S, Pikora M, Quick D, Stenger P. (2008). Effect of frequency transposition in school-aged children. Poster presented at: American Academy of Audiology annual convention; April 2008; Charlotte, NC.