# American Four Alternative Auditory Feature Test: Development and Validation

Jingjing Xu and Robyn M. Cox
Hearing Aid Research Laboratory, University of Memphis, Memphis, TN
Presented at the American Auditory Society Convention, Scottsdale, AZ, March 2010

## INTRODUCTION

The Four Alternative Auditory Feature test (FAAF) is a word recognition test which was originally developed in the MRC-Institute of Hearing Research, U.K. The FAAF has been widely used for hearing research (e.g., Gatehouse et al., 2003) and revealed that it is sensitive in evaluating speech recognition performance in various noise conditions. However, considering the differences between American English and British English, the FAAF cannot be used in the U.S. and the development of an American FAAF (AFAAF) is needed. The purpose of this project was to develop the AFAAF and evaluate its validity and reliability. Permission was obtained from the FAAF developers. Results of this validation study were compared to a previous study in which the original FAAF was utilized under similar test conditions.

## STRUCTURE OF THE AFAAF

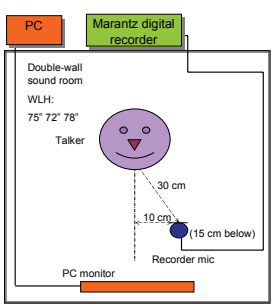
The AFAAF materials are identical to the FAAF. The FAAF is a word-based closed-set test that is presented under software control. Each key word is embedded in a carrier sentence: "Can you hear _____ clearly?" There are 80 test and 5 practice trials with 5 pre-determined test orders for the test-trial words. Test conditions can be quiet or in the presence of noise. A test subject listens to each presentation and selects a word from 4 displayed alternatives. The performance measure is the percentage of the words that are correctly identified. An example is:

*Can you hear **old** clearly?*

and the 4 displayed alternatives are:

***hold**, **old**, **cold**, **gold**.*

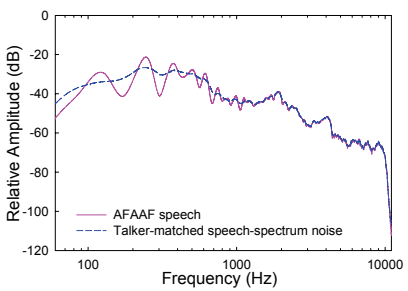
## PRODUCTION OF AMERICAN VERSION




Setup for recording the AFAAF speech stimuli. The recording strategy used here followed the suggested one used for the FAAF in the MRC-Institute of Hearing Research.

## • Recording and audio file editing

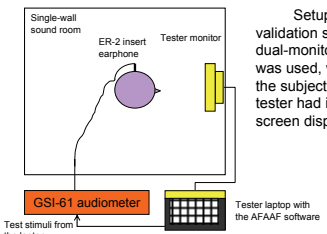
- **Recording environment**: a double-wall sound room (ambient noise level: 40 dB SPL Lin.).
- **Talker**: a native American-English speaking male without a regional accent.
- **Recording devices**: a Marantz PMD660 digital recorder with an external recorder microphone.
- **Recording format**: mono .WAV files @ 44.1kHz and 16-bits.
- **Target word presentation**: word-by-word fashion displayed on a computer monitor; the talker spoke the target word with the carrier phrase.
- **Speech spectrum**: (40 to 20kHz) was obtained from the recorded AFAAF speech without gaps between utterances using SpectraPLUS 5.0 program.
- **Masking noise generation**: the spectrum of the AFAAF speech was used to filter 3 noises: (1) steady-state random noise; (2) modulated noise 1 from ICRA CD track 6; (3) modulated noise 2 from ICRA CD track 7.
- **Audio files for the AFAAF**: (1) 1kHz calibration tone (15 sec); (2) 1kHz octave-band calibration noise (15 sec); (3) test speech (about 2 sec for each utterance); (4) talker-matched random noise (15 sec); (5) talker-matched modulated noise 1 (15 sec); (6) talker-matched modulated noise 2 (15 sec).
- **Digital signal processing**: all the speech signals and the masking noises were bandpass-filtered from 70Hz to 10kHz; the RMS power of each test sentence (carrier phrase + key word), each masking noise, and each calibration signal was digitally equalized using Adobe Audition 1.0.




Long-term spectra of AFAAF speech and talker-matched random noise at equal power.

## VALIDATION STUDY

## • Methods

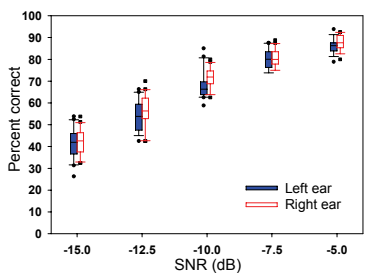



Setup for the validation study. A dual-monitor system was used, with which the subject and the tester had identical screen displayed.

- **Participants**: 20 young normal hearers (5 M and 15 F); they were tested monaurally on each ear.
- **Transducer**: an Etymotic Research ER-2 insert earphone which provides a flat frequency response up to about 10kHz measured in a Zwislocki coupler.
- **Masking noise**: a talker-matched random noise.
- **Test conditions**: -15, -12.5, -10, -7.5, and -5 dB SNRs with a fixed speech level at 70 dB SPL.
- **Test administration**: all 80 key words were used for each condition. SNRs and word orders were counterbalanced.

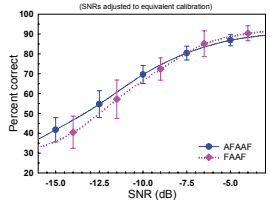
## • Results and Discussions

Each subject had 5 scores (% correct) for each ear. These data were analyzed with regard to (1) performance-intensity (PI) function, (2) SNR step size used in this study, and (3) test-retest reliability.



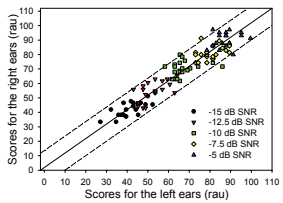

Box-and-whisker plots show the speech recognition scores for both ears at each SNR condition.

PI functions for the AFAAF and the FAAF (±1 SD).




❖ The PI function for the AFAAF has a slope of 5.15%/dB compared with 5.95%/dB for the original FAAF (Foster & Haggard, 1987).

❖ For statistical analyses, the scores in percentage were converted into rationalized arcsine units (rau) (Studebaker, 1985). Each 2.5 dB change in SNR condition produced a significant difference in performance.




❖ The 95% critical difference for the AFAAF is about 12 rau.

## CONCLUSIONS

The AFAAF is an American dialect version of the original British FAAF: a four-alternative closed-set speech recognition test. Results from this validation study indicate that these two tests are equivalent.

## REFERENCES

Foster, J., & Haggard, M. (1987). The four alternative auditory features test (FAAF) – linguistic and psychometric properties of the material with normative data in noise. *Brit J Audiol, 21*, 165-174.

Gatehouse, S., Naylor, G., & Elberling, C. (2003). Benefits from hearing aids in relation to the interaction between the user and the environment. *Int J Audiol.* 42 Suppl 1, S77-85.

Studebaker, G.A. (1985) A "Rationalized" Arcsine Transform. *J Speech Hear Res, 28,* 455-462.

## ACKNOWLEDGEMENT

John Foster, MRC-Institute of Hearing Research
David J. Wark, Ph.D., The University of Memphis

Please contact *jxu3@memphis.edu* for further information.
PDF-version of this poster can be obtained at
*http://www.memphis.edu/ausp/harl*

HARL
Hearing Aid Research Lab