



# Evaluating In-situ Loudness Mapping vs. an Audiogram Based Fitting Procedure

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## ABSTRACT

Hearing aids often require multiple "tweaking" sessions to arrive at a satisfactory fitting. In this study, a comparison is made between the recommended fittings based on the audiogram, and an in-situ loudness mapping procedure. These two fitting strategies are evaluated against the subjects' final, preferred fitting, following multiple visits. Of concern is whether the extra time required by the loudness mapping procedure creates a fitting that is closer to the subjects' final, preferred fitting.

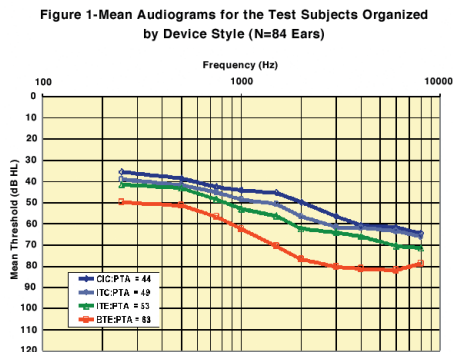
# INTRODUCTION

Most hearing care professionals would probably agree with the proposition that hearing aids often require multiple fitting or adjustment sessions before an end-user becomes satisfied with his/her experience with amplification. Many advanced-technology hearing instruments include some form of loudness mapping procedure as part of the fitting process with an eye towards minimizing the number of these follow-up "tweaking" sessions. However, due to time constraints in the busy practice, such loudness mapping procedures often take a back seat to the "instant" fitting solution. Furthermore, some hearing care professionals have reported that the recommended audiogram-based fitting provides very good initial settings and, therefore, does not justify the slightly greater time expenditure required by the dynamic range mapping procedure. In the interest of shedding light on this issue, this presentation directly evaluates the efficacy of SONIC innovations' implementation of the "Best Fit , Fast™ fitting philosophy as expressed through both the audiogram-based, and loudness-mapping fitting approaches.

In this study, a comparison was made between the original recommended fitting based on a proprietary audiogram-based algorithm and an in-situ dynamic range mapping procedure termed "Verify Dynamic Range" or VDR. The VDR procedure measures the deviations in the dynamic range of the listener with respect to published loudness contours. These individual dynamic range differences are automatically factored into the fittings generated by the EXPRESSfit™ software to optimize gain and output in all of the hearing devices. Both fitting methods were compared to the final, preferred fitting after multiple follow-up visits. The primary goal of this study was to establish whether the extra time required by the VDR procedure created a fitting that was closer to the subject's final, preferred setting, when compared to the initially quicker audiogram-based method.

# SUBJECTS & PROCEDURES

The forty-two subjects selected in this study were participants in device-worn field trials for the NATURA™ 2 SE, including CIC, ITC, ITE, and BTE hearing devices. The primary purpose of these field trials was to gather performance, sound quality,



reliability, and fitting preference data during product development. The participants included 26 males and 16 females with an average age of 61.2 years. All but two subjects were experienced digital hearing aid wearers.

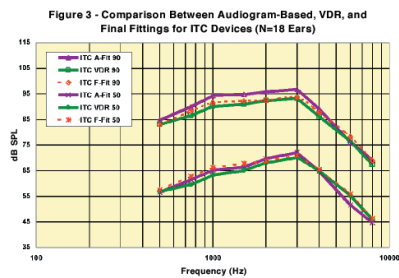
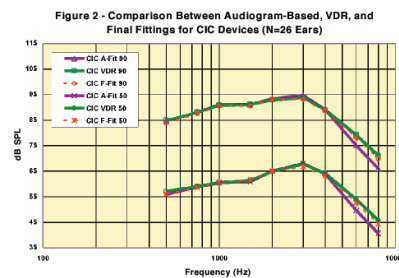
Subjects were assigned to one of the device styles according to the degree of hearing loss and the fitting range allowed by the respective instruments. Figure 1 depicts the mean audiograms for the subjects arranged by device style. 13 subjects were assigned to the CIC devices, 9 in each of the ITC and ITE groups, and 11 in the BTE condition.

At the initial fitting, the EXPRESSfit, audiogram-based settings were recorded, but not actually used. Instead, subjects underwent a modified VDR procedure where loudness judgments were made using adjacent pairs of tones. This method is contrasted with the original procedure which required subjects to listen to all 9 tones as they automatically swept from 500 to 8000 Hz. Some subjects reported difficulty with the original VDR procedure, hence the switch to the pairwise comparison method. The new VDR procedure was well-received by both subjects and clinicians alike.

Throughout the study, the fittings were adjusted to address patient preferences and typical issues such as feedback, occlusion, and overall volume level. At the conclusion of the field trials, the final, preferred program settings were recorded. These final fittings became the gold-standard against which the efficacy of the audiogram-based and VDR fitting procedures were evaluated.

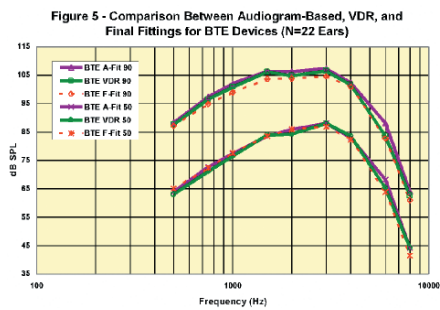
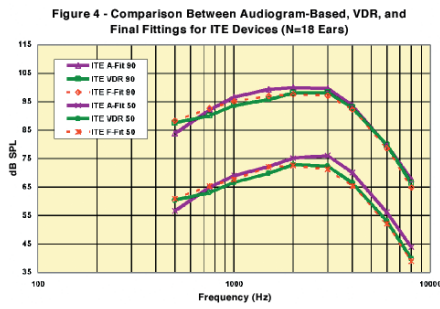
# RESULTS

Figures 2-5 demonstrate the predicted mean fitting outcomes for both the audiogram-based and the VDR approaches, as well as the mean final, preferred fitting for each of the device styles.



The final fittings themselves were recorded 6 to 15 weeks following the initial fitting, depending on when subjects completed their field trials. Overall, the final fittings followed the general curve shapes predicted by both EXPRESSfit methods.

However, the audiogram-based fittings overestimate output at the 90 dB input level

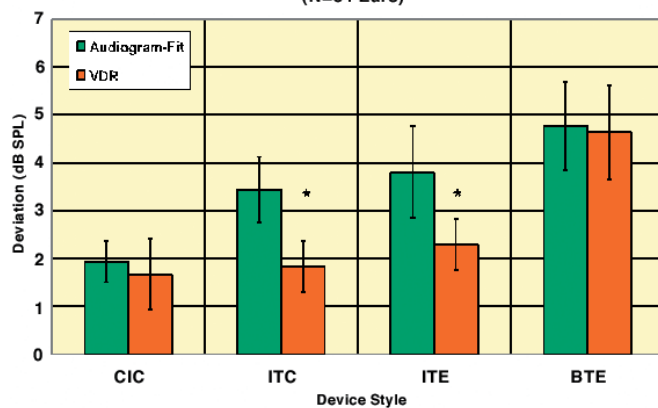


for all device styles by 2-3 dB, except for the CIC wearers. This slight overestimation was not restricted to the high-input levels but could also be found at the 50 dB input level for the ITE device users. Descriptively, the VDR procedure yielded fittings that were closer to the final setting and tended to prescribe slightly less gain and output than the audiogram-based method.

Since the primary focus of this presentation centers on making a comparison between the audiogram based and VDR fitting strategies (with respect to how closely they predict the final fitting), the negative and positive deviations from the final fit were converted to absolute deviation scores.

The deviation data were collapsed across 9 frequencies and 2 input levels for each of the device styles. Mean values are shown in Figure 6.

**Figure 6 - Mean Deviation From the Final Fitting for the Audiogram-Based and VDR Procedures Across Device Style (N=84 Ears)**



As shown in Figure 6, the VDR procedure yielded less deviation from the final, preferred fitting when compared to the audiogram-based fitting [F(1,80) = 22.33, p < .001]. Additionally, a significant main effect of device style was found [F(3,80) = 9.31, p < .001] supporting the observation that the fitting deviations became greater as device style became larger (or more precisely, as hearing loss became greater).

A statistically significant interaction between fitting method and device style indicated that the effects of fitting procedure varied with device style [F(3,80) = 4.41, p = .006]. Specifically, the mean VDR deviations were significantly less than the audiogram-based fittings for ITCs and ITEs.

## CONCLUSIONS

The VDR procedure yields improved fitting accuracy compared to the audiogram-based method, particularly for the ITC and ITE devices. The mean VDR-fit advantage for these two device styles was 1.5 dB, signifying a 40-45% improvement in predicting the final "best" fit. Additionally, the VDR method maintains a relatively small and stable amount of fitting deviation when compared to the audiogram-based procedure, particularly for those individuals wearing custom devices. Given that the CIC wearers in this study exhibited the least amount of deviation, both fitting methods were judged to be equally effective at predicting the final, preferred fitting. Because of the improved fitting accuracy afforded by the VDR approach, the extra time spent performing this procedure should lead to improved initial fittings, a reduction in the number of repeat visits for program "tweaking," and a lower return for credit rate.

"Best Fit, Fast" is best achieved using the VDR approach.

