

More Than a “Touch” of Benefit in a New RIC Device

Introduction

This article reports on a recently completed study evaluating the performance and benefit received by hearing-impaired individuals wearing Sonic Touch™, a new receiver-in-the-canal (RIC) product family introduced by Sonic Innovations® in April, 2009. The product family includes the premium-level Touch 24, the advanced-level Touch 12, and the mid-level Touch 6. The three technology levels differ in terms of their number of compression channels, their complement of features, and the number of available programs. The Sonic Touch family is based upon a micro RIC form factor shown in Figure 1. Touch defaults to an open-canal configuration, but software transforms allow clinicians to fit the device in occluded- or closed-canal configurations (using a standard tulip or power dome or a custom earmold) when an extended fitting range is desired.

Sonic Touch implements many technologies and features that are already available in the Sonic Innovations Velocity™ family, such as Sonic Sound™, Automatic Directionality, Focused Null-Steering, DIRECTIONALfocus™, digital noise reduction, fixed and adaptive feedback cancellation, data logging, and Voice Alerts.

The results of this study reveal that both the open- and closed-canal configurations of Touch 6, 12 and 24 provide significant benefit to wearers in various programmed listening environments. Subjects demonstrate objective speech understanding benefit in quiet and in noise, and perceive significant subjective benefit relative to not wearing hearing aids. The subjects are satisfied with Touch overall, with 75% of individuals reporting that they are “considerably” or “tremendously”

satisfied. The majority of subjects with prior hearing aid experience report that Touch is “much better” than their previous hearing aids, and rate the sound quality and physical design of Sonic Touch very highly.

Study Design

Subjects

Thirty-two hearing-impaired individuals (20 male, 12 female) ranging in age from 47 to 81 years, with a mean age of 67.8 years, participated in the study. All had bilateral, symmetrical, sensorineural hearing loss, and were fit binaurally with Touch 6, Touch 12, or Touch 24 micro RIC hearing aids. Twenty-five individuals had normal or near-normal audiometric thresholds in the low frequencies, and were therefore fit in an open-canal configuration using a non-custom, one-size-fits-all open dome, whereas seven individuals had more significant low-frequency hearing loss, and were fit with custom molds in a closed-canal configuration (see Figure 2). All subjects were fit using Sonic Innovations Best Fit Fast® fitting rationale.

Procedures

This study was designed to verify that the hearing aids were performing as expected using coupler and real-ear measurements, to evaluate speech understanding in quiet and noise using the Hearing In Noise Test (HINT)¹, and to validate performance using benefit and satisfaction questionnaires. Subjects were seen for five sessions scheduled approximately weekly over a five week period. Subjects were randomly assigned to be fit with either Touch 6, 12, or 24, and the fittings were verified using 2-cm³ coupler measurements and probe microphone measurements using the Frye Fonix 7000 Hearing Aid Test



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Figure 1: Sonic Touch micro RIC with receiver assembly and open dome.

Mean Right and Left Audiograms (OPEN n=25; CLOSED n=7)

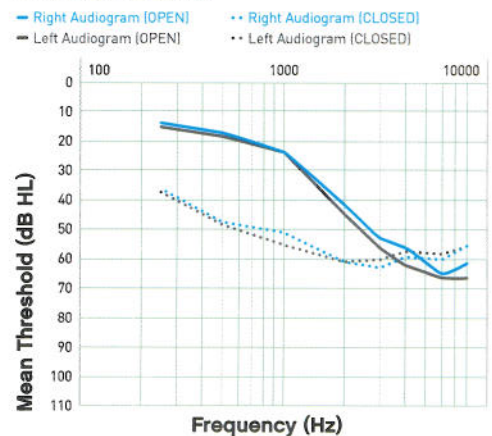


Figure 2: Mean audiometric thresholds for 25 subjects fit with Touch devices in an open-canal configuration with the Sonic Innovations open dome, and 7 subjects fit with closed, custom molds.

System. Unaided and aided HINT testing was completed in speech-shaped background noise. Loudspeakers were arranged such that the HINT sentences were presented from in front of the listener at 0° azimuth, and uncorrelated masking noise was delivered simultaneously from four loudspeakers positioned at azimuths of 45, 135, 225, and 270°, creating a two-dimensionally diffuse broadband noise². For self-assessment of benefit in familiar listening situations, subjects completed the Abbreviated Profile of Hearing Aid Benefit (APHAB)³. Unaided responses were obtained at the first session, prior to being fit with Touch, and aided responses were obtained at the final session. At the final session subjects also completed a questionnaire asking about their satisfaction with the devices along several dimensions using a seven-point scale, and answered questions about sound quality, feedback, telephone and cell phone usage, use of the battery door and push button, and comfort and retention of the devices. At each visit, subjects were given daily dairies to record problems, positive findings, wear times, and program usage.

Results

Target Matching – Coupler

To verify that the devices were operating as expected and providing appropriate gain across the speech spectrum, the fittings generated by the Best Fit Fast algorithm were verified against targets generated for the 2 cm³ coupler and real ears. Devices were programmed for each subject's hearing loss and set to use an omnidirectional microphone. The devices were configured for either an open- or closed-canal, as appropriate for the hearing loss. Fitting values from the software were compared to actual 2-cm³ coupler measurements of a pure-tone sweep at input levels of 50 and 90 dB SPL (see Figure 3). There is very good agreement (within 5 dB) between the 50- and 90-dB fitting values and the coupler measurements from 250 through 6000 Hz, indicating that what the clinician sees on the software screen is what the

device actually delivers.

Target Matching – Real Ear

Best Fit Fast real-ear target values from the software were compared to probe-microphone measurements of the sound pressure level as delivered to real ears. Given the wide variation among human ear canals, it should not be expected that the measurements obtained from any given ear will be a perfect match to the software targets, but rather the mean of a large sample of ears will reflect the real-ear targets shown on the screen. All probe-microphone measurements were obtained using an omnidirectional microphone with noise reduction, expansion, and feedback cancellation disengaged. Figure 4 depicts the average match to real-ear aided response (REAR) Best Fit Fast targets for 38 ears in this study for a 50- and 90-dB SPL pure-tone sweep. Note that only 38 ears were used in this sample, as the software targets were still being finalized and not available until the latter part of the study. In general, there is exceptional agreement (within 3 dB) between the real-ear target and measurement values at all frequencies.

Speech Perception In Noise Benefit

Unaided and aided HINT testing was completed in diffuse background noise; the presentation level of the noise was 65 dBA and an adaptive procedure was used to obtain reception thresholds for sentences in terms of a signal-to-noise ratio (dB SNR). Figure 5 (following page) shows the mean HINT results separately for the open- and closed-canal configurations for four test conditions; unaided, and aided in the Universal, Quiet, and Noise environments. The Universal environment uses Sonic Innovations' patented DIRECTIONALfocus adaptive directional technology, the Quiet environment uses a fixed hypercardioid directional response, and the Noise environment uses null-steering adaptive directional technology. In all environments, noise reduction was set to the default setting (as determined by the audiometric thresholds)

Coupler Target Matching (n=64 devices)

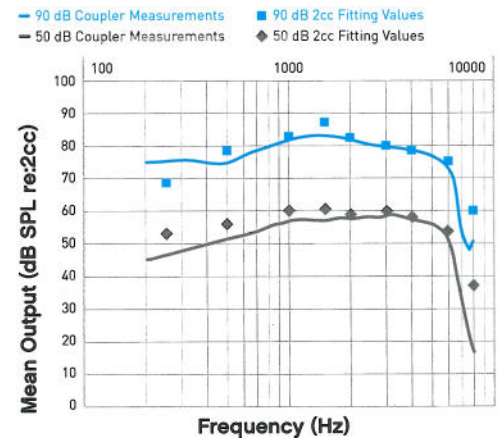


Figure 3: Comparison of target fitting values and actual coupler measurements with 50- and 90-dB SPL pure tone inputs. Results are averaged across 64 Touch devices.

Real-Ear Target Matching (n=38 ears)

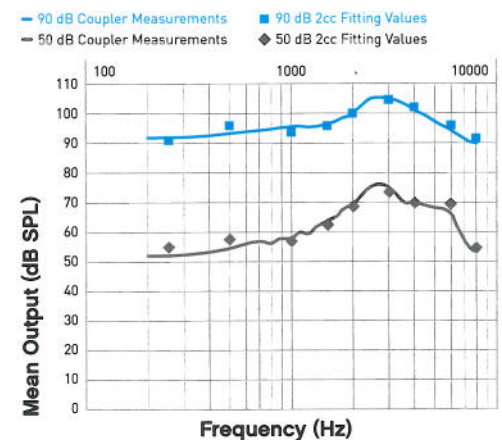


Figure 4: Comparison of REAR target fitting values and mean hearing aid output in the real ear for 50- and 90-dB pure-tone inputs. Results are averaged across 38 ears.

and the feedback canceller was on.

As expected, benefit was considerably greater in the closed-canal configuration than in the open-canal configuration, due to the exceptional unaided performance of the individuals fit with the open configuration. In general, these individuals have normal or near normal low-frequency hearing thresholds and are expected to perform well on the HINT unaided. Thus, there is not much margin for improvement in this particular population. For the open-canal configuration, the average benefit in noise relative to unaided was 1.2, 1.6, and 1.2 dB for the Universal, Quiet, and Noise environments, respectively. For the closed-canal configuration, the average benefit in noise relative to unaided was 5.6, 4.0, and 4.0 dB for the same environments. A repeated-measures analysis of variance reveals significant main effects of device configuration ($F[1,30]=5.59, p<.05$) and test condition ($F[3,90]=24.39, p<.001$), and a significant interaction ($F[3,90]=8.79, p<.001$) between those two variables. Post hoc analyses with Bonferroni corrections reveal that the unaided test condition is significantly different from any of the aided conditions, yet none of the aided test conditions are different from each other. This finding is also true when the open- and closed-canal device configurations are analyzed separately, indicating that even the smaller 1.2 - 1.6 dB of aided benefit observed in the open-canal configuration is significant.

Subjective Benefit and Satisfaction Ratings

The APHAB questionnaire was completed at the first session based on the subjects' perceptions of their performance unaided, and again at the final session based on their perception of their performance aided with Touch. An APHAB benefit score was calculated as the percent of problems reported unaided versus aided. Average results for the APHAB subscales [Ease of Communication (EC), Reverberation (RV), Background Noise (BN), and Aversiveness (AV)] are shown

in Figure 6 for the 25 subjects fit with an open-canal configuration, and in Figure 7 for the seven subjects fit with a closed-canal configuration. Results indicate that, on average, subjects perceived significant benefit from Touch relative to not wearing hearing aids on each of the Speech Communication subscales (differences greater than 22% are considered significant). If one considers individual benefit, 91% of subjects perceived benefit scores of 10 points or more on all three Speech Communication (EC, RV, and BN) subscales. Further, wearing Touch does not make sounds more aversive than not wearing hearing aids.

Subjects also completed a questionnaire asking them to rate their level of satisfaction with Sonic Touch using a 7-point scale from 1 (NOT AT ALL SATISFIED) to 7 (TREMENDOUSLY

Abbreviated Profile of Hearing Aid Benefit (n=32)

■ UNAIDED ■ AIDED ■ DIFFERENCE

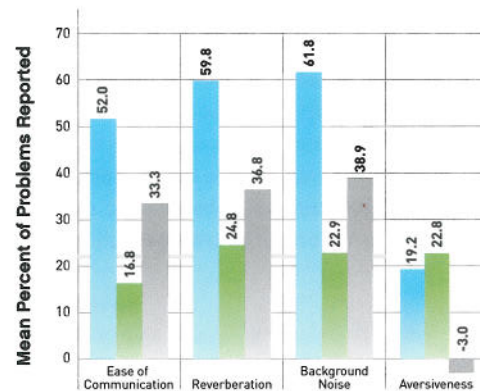


Figure 6: Average APHAB ratings for 32 subjects fit with Touch in an open-canal configuration.

(SATISFIED). The results are summarized in Figure 8 (following page). The average satisfaction ratings for all 32 subjects for performance in quiet environments, in noisy environments, on the telephone, and the hearing aids overall were 5.9, 5.3, 5.4, and 6.0, respectively. It was only for performance on the telephone that

HINT Performance in Noise

■ OPEN (n=27) ■ CLOSED (n=7)

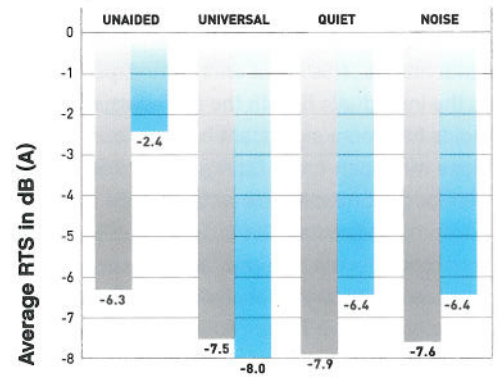


Figure 5: Average HINT results in noise for the open-canal (n=25) and closed-canal (n=7) configurations. Results are shown unaided and aided in the Universal, Quiet, and Noise environments. Lower thresholds equate to better performance.

Abbreviated Profile of Hearing Aid Benefit (n=7)

■ UNAIDED ■ AIDED ■ DIFFERENCE

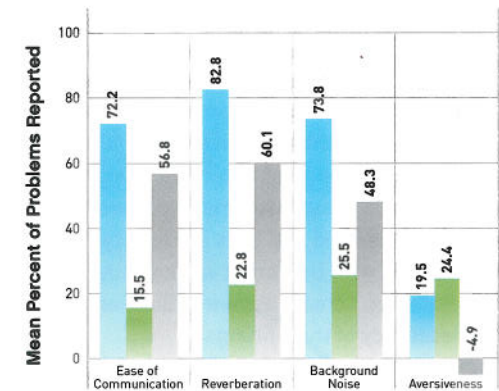


Figure 7: Average APHAB ratings for 7 subjects fit with Touch in a closed-canal configuration.

the open- and closed-canal fittings yielded noticeably different satisfaction ratings. The average rating for the open-canal fittings was 5.8, whereas it was only 3.9 for the closed-canal fittings. This is not entirely unexpected, as the individuals fit with the closed, custom molds had more significant hearing loss than those with open-canal fittings, and most were accustomed to aids with telecoils. The extraordinarily small size of Touch devices does not accommodate currently available telecoils, thus leading to lower satisfaction with telephone usage. In addition, subjects were asked to rate the overall sound quality and physical design of Sonic Touch; the average ratings for all subjects were very high, at 6.0 and 6.4, respectively.

Conclusions

In this study, Sonic Touch micro RIC devices were shown to provide significant benefit for speech understanding in noise in the laboratory for both open-canal and closed-canal fittings. The laboratory finding was corroborated by subjective reports of significant benefit in the real world for both types of fittings. Individuals were highly satisfied with the performance of the devices in different environments, and rated the sound quality and physical design of Sonic Touch highly. In addition, electroacoustic measurements in a 2cm³ coupler and real ears are in very close agreement with the target values shown on the software screen, assuring clinicians of the accuracy of their fittings.

References

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Figure 8: Average satisfaction ratings for performance in quiet, in noise, on the phone, and overall, using a 7-point scale (1=Not at all; 7=Tremendously). Using the same scale, subjects also rated the overall sound quality and physical design of Touch.