

NIH-NIDCD Smartphone-based Hearing Aid Project

Clinical Testing and Results, Year 2

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April 23, 2018

Data Collection Overview:

Clinical verification was conducted to determine the benefit that the algorithms might have for persons with normal hearing.

Experimental Setup:

The test arrangement for evaluation of the speech recognition in background noise with the smartphone algorithms is shown in Figure 1.

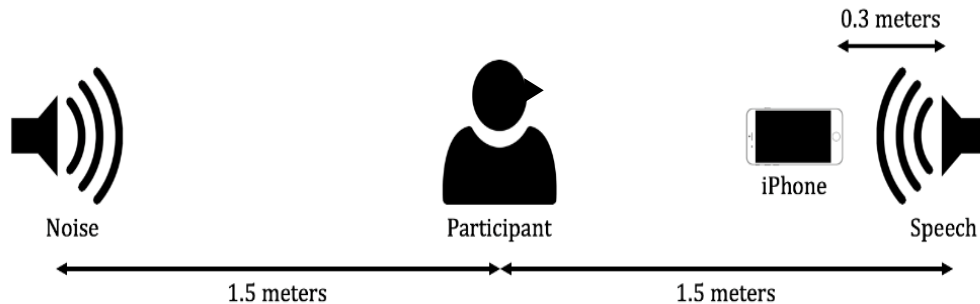


Figure 1. Testing arrangement for evaluation of noise reduction and speech enhancement algorithms on IOS and Android smartphones.

Phase 1: Comparison of iJMAP to Live Listen with Starkey Halo 2 Hearing aid in normal hearing subjects

The purpose of this phase is to test how college-age, normal-hearing listeners perform using Live Listen and iJMAP [(i.e. processed through algorithm) with multi-talker babble varying signal-to-noise ratio (SNR) values. The data were collected from 9/25/2017-2/20/2018. The equipment used included noise routed through back speaker and signal routed through front speaker inside the booth. The background noise was presented at 65 dB SPL (0dB SNR), 70 dB SPL (-5dB SNR) and 75 dB SPL (-10 dB SNR) for Live Listen and iJMAP conditions. The beta value was set to .9. Noise cancelling headphones were worn over top the hearing aids. Hearing aid technology included participants wearing Starkey Halo 2 hearing aids which were programmed to 10 dB HL thresholds (NAL-NL2) across all frequencies (250-8000 Hz) to simulate normal hearing.

Conclusions: As shown in Table 1 and Figure 2, the app developed for speech enhancement provides access to speech sounds at the same level or better than Live Listen.

Table 1. Percent correct scores for cJMAP and Live Listen apps on the iphone when listening through paired Starkey Halo II hearing aids in normal-hearing college students.

n=25	0 SNR		-5 SNR		-10 SNR	
	cJMAP	Live Listen	cJMAP	Live Listen	cJMAP	Live Listen
Mean	92.95	92.53	83.12	81.31	71.48	65.99

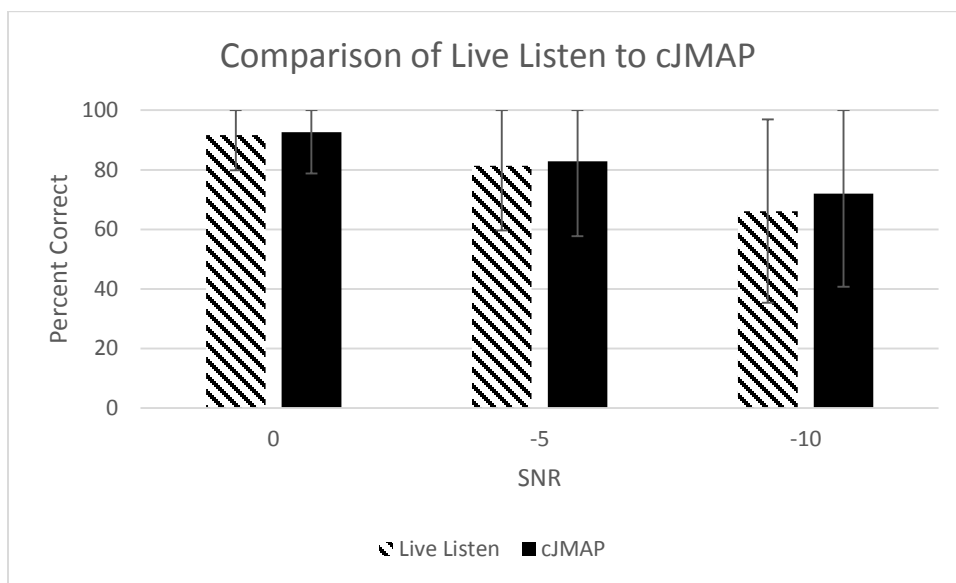


Figure 2. Percent correct scores at three signal-to-noise ratios for cJMAP and Live Listen apps on the iphone.

Phase 2: Comparison of Beta values in ccJMAP with Starkey Halo 2 hearing aid in normal hearing subjects

The purpose of this phase was to test how college-age, normal-hearing listeners perform under different Beta values in ccJMAP (i.e. processed through algorithm) with multi-talker babble at varying SNR values. The equipment used included noise routed through the back speaker and the signal routed through the front speaker inside the sound booth. The background noise was presented at 75 dB SPL (-5 dB SNR), and 80 dB SPL (-10 dB SNR) for ccJMAP with different Beta values (mutli-talker, babble noise resembling noisy restaurant environment). Noise cancelling headphones were worn over top the hearing aids. Beta in ccJMAP was set to .5, 1, 1.5, 2, and 2.5. Hearing aid technology included participants wearing Starkey Halo 2 hearing aids which were programmed to 10 dB HL thresholds (NAL-NL2) across all frequencies (250-8000 Hz) to simulate normal hearing.

Babble Noise The data were collected from 10/13-10/16/2017.

Traffic Noise: The data were collected from 10/24-10/30/2017.

Machinery Noise: The data were collected from 11/6-11/26/2017.

Conclusions: Analysis of the Beta showed that .5 was the best for speech recognition with each type of background noise with the exception of -5 dB SNR for machine noise where Beta 1.0 yielded the best average speech recognition score.

Table 2. Percent correct scores for ccJMAP on the iphone when listening through paired Starkey Halo II hearing aids in normal-hearing college students.

Percent Correct Scores for three Noise Types and Five Beta Settings					
	Beta 0.5	Beta 1.0	Beta 1.5	Beta 2.0	Beta 2.5
BABBLE N=7					
SNR -5dB	93.70	80.56	69.31	69.81	55.65
SNR-10dB	63.39	61.82	55.92	40.57	44.69
TRAFFIC N=13					
SNR -5dB	80.97	74.02	74.11	77.08	63.21
SNR-10dB	60.88	56.59	46.01	48.94	52.52
MACHINE N=11					
SNR -5dB	83.61	85.31	64.85	73.83	75.83
SNR-10dB	69.90	63.93	58.73	57.61	61.79

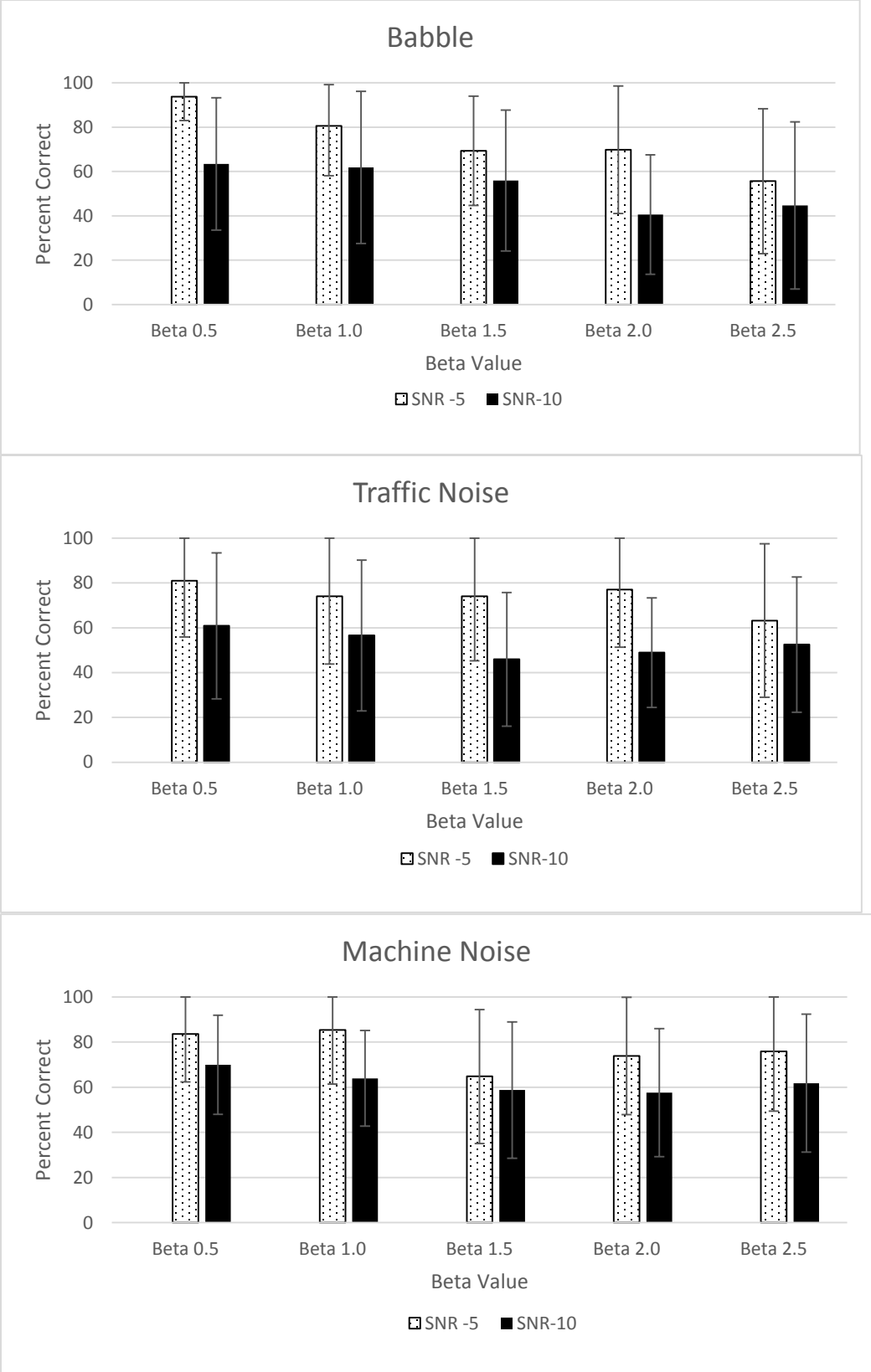
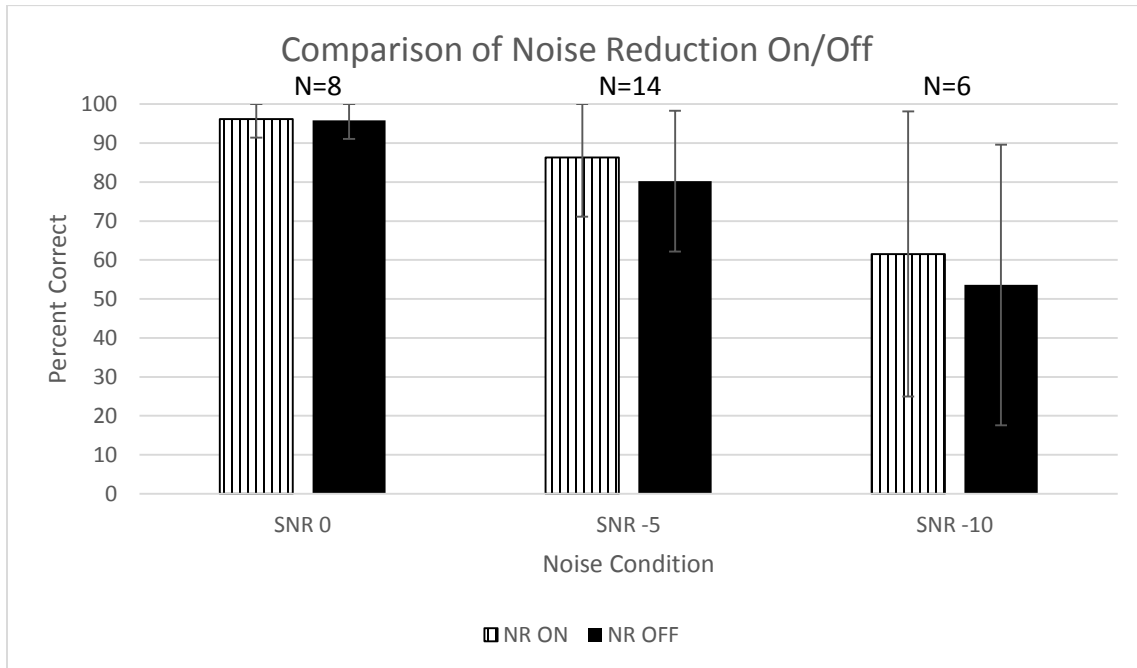


Figure 3. Percent correct scores at two signal-to-noise ratios for ccJMAP at five Beta settings.

**Phase 3: Comparison of ccJMAP with Noise Reduction On and Off
and with Live Listen using Starkey Halo 2 hearing aid in normal hearing subjects
n = 14**

The purpose of this phase is to test how college-age, normal-hearing listeners perform with the same Beta value (B=0.7) in speech noise. The data were collected from 4/3-4/13/2018. The equipment used included speech noise routed through the back speaker and the signal routed through a Bose speaker calibrated to 65dBA. The background noise was presented at varying SNR levels (0dB, -5dB, and -10dB) with ccJMAP on and off and using Live Listen. Noise cancelling headphones were worn over top the hearing aids. The app was restarted at the beginning of every sentence list. Hearing aid technology included participants wearing Starkey Halo 2 hearing aids which were programmed to 10 dB HL thresholds (NAL-NL2) across all frequencies (250-8000 Hz) to simulate normal hearing. Below is the corrected, combined data of fourteen participants:

n=10									
Condition	0dB	-5dB	-10dB	0dB	-5dB	-10dB	0dB	-5dB	-10dB
Program	ccJMAP	ccJMAP	ccJMAP	ccJMAP	ccJMAP	ccJMAP	Live Listen	Live Listen	Live Listen
Noise reduction	ON	ON	ON	OFF	OFF	OFF	-	-	-
BETA LEVEL	0.7	0.7	0.7	0.7	0.7	0.7	-	-	-
MEAN	96.14	86.28	61.54	95.81	80.23	53.58	99.06	86.37	60.86
STDEV	49.49	15.13	40.68	49.33	18.08	36.01	50.88	15.25	33.65



Conclusions: Optimal speech recognition occurs across noise levels when the noise reduction algorithm is turned on. The benefit is greatest when the SNR is -10 dB.