Evaluation of Soft Silicone Type NAM Microphones

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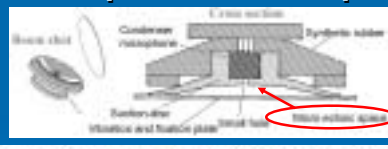
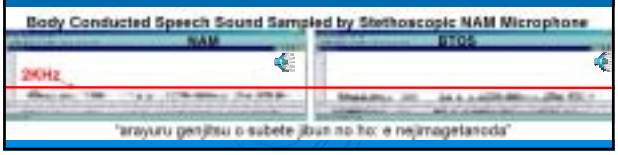
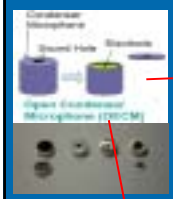
- NAM Microphone = Sensor for Sampling Flesh Conducted Soft Breathed Voices (Non-Audible Murmur; NAM)
- BTOS (Body Transmitted Ordinary Speech) = Flesh Conducted Normal Speech sampled by NAM Microphone

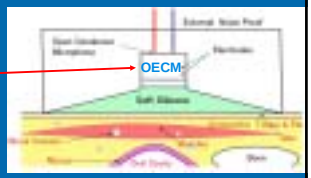
Stethoscopic NAM Microphone



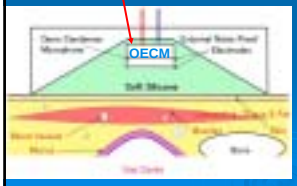


Soft Silicone NAM Microphone

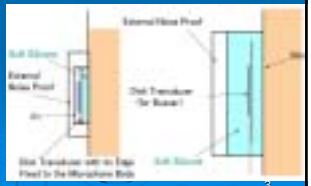




OCMSS Type

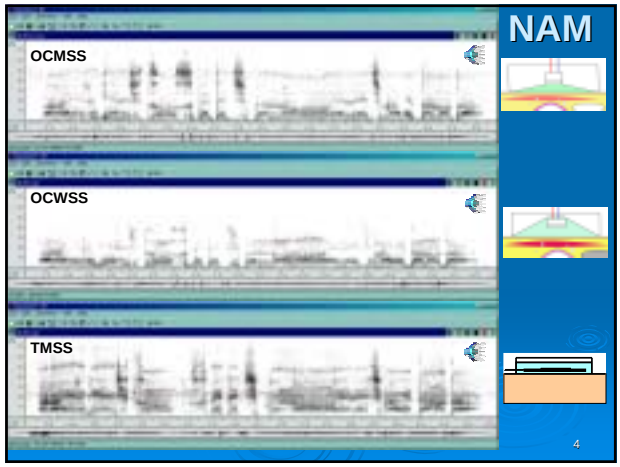


OCWSS Type

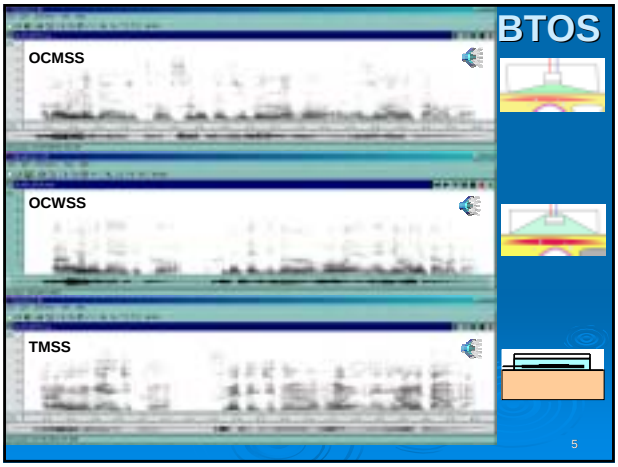


TMSS Type

NAM

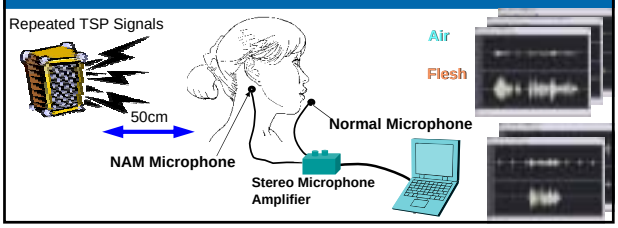


BTOS

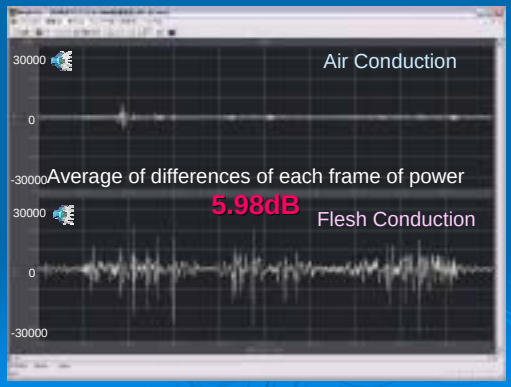


Synchronous Stereo Sampling of Air and Flesh Conducted Voices at the Same Gain

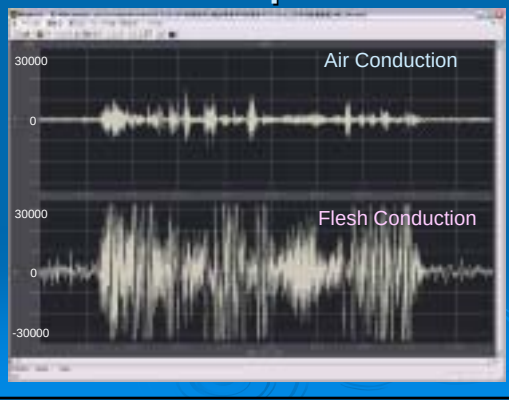
- Condenser microphones of the same serial number of the same company were used.
- The air conduction voice was collected in the distance of 5cm from the mouth and the flesh conduction voice was sampled with the NAM microphone of the OCMSS type.
- Right and left tracks were set with the stereo at the same output level and the same amplification rate.



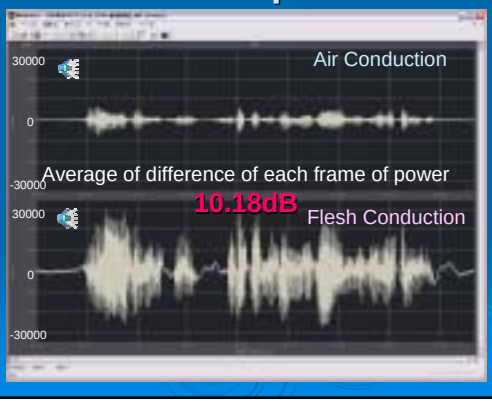
NAM



Whisper



Normal Speech



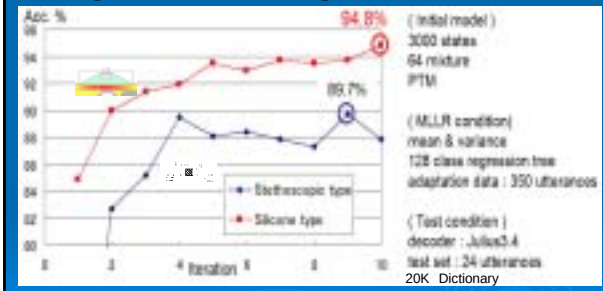
NAM and Background Repeated TSP Sound

Pay attention to the ratio of amplitudes of a target signal and the noise signal.

BTOS and Background Repeated TSP Sound

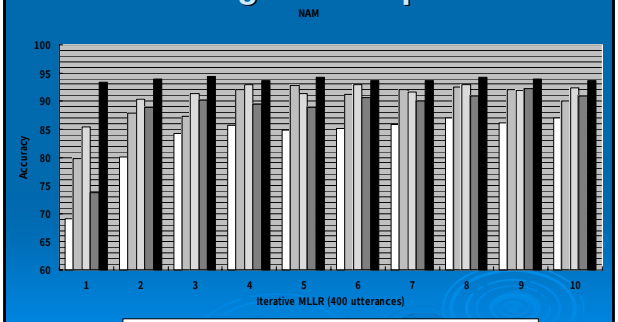
Pay attention to the ratio of amplitudes of a target signal and the noise signal.

Evaluation of NAM microphones by HMM Recognition Rates

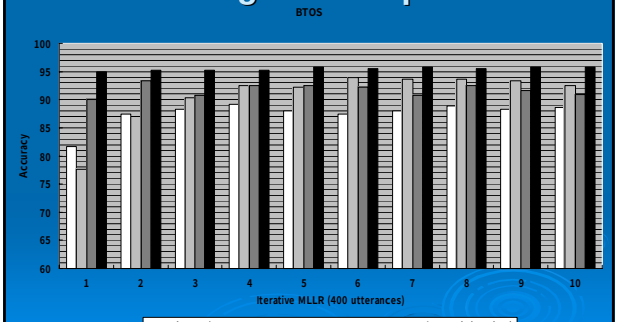


Comparison of NAM recognition rates of soft silicon type and stethoscope type

NAM recognition accuracy according to microphones



BTOS recognition accuracy according to microphones



Aural Comprehension Test Using Soft Silicone Type NAM Microphone

I. **Sentence Utterances**
1. 会議が始まる前に，携帯電話の電源を切って下さい．
2. 11日の同窓会には，葉書とアルバムを持ってきてください．
3. 明日のミーティングは，午後7時から第二会議室で行います．
4. お金は昨日の午前中に，指定の口座に振り込みました．
5. 帰りにスーパーでチューブ入りのわさびを買ってきてね．
6. 私の父は昭和17年の生まれで，戦後の人間です．
7. 書店に注文している本が，明日の夕方に届くはずです．
8. 五千円からですと，おつりは247円になります．
9. 予約したチケットの料金は，コンビニからでも払えるよ．
10. 頭が痛くて熱が出てきたので，今日は学校を休むことにする．
11. 犬は飼うなと叱られたので，鳥を飼うことにしました．
12. もう少し明るい場所で，きちんと座って本を読みなさい．

II. **Single Words**
1. 腕時計　2. カーテン　3. 爪切り　4. 弁護士　5. あじさい　6. 双子座
7. 模擬テスト　8. 上流社会　9. 図書館　10. 町並み　11. 街路樹　12. コーヒー

III. **Meaningless Words**
1. かがら　2. むぶぶ　3. のとど　4. えほしゃ　5. うふに　6. ねっけ
7. かーちゅ　8. りょっき　9. さーじつ　10. ほびゅば　11. ちしじ　12. なだた

Variety and Allocation of the Samples

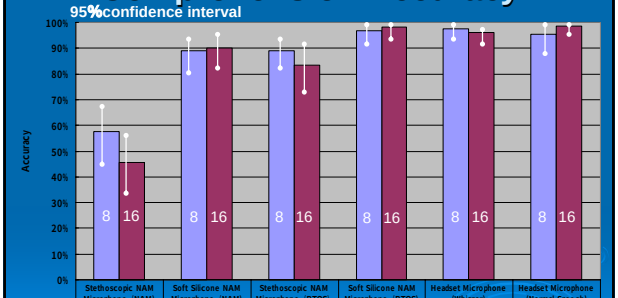
random permutation of 12 kinds of records for each rank

Every testee was supposed to listen to each utterance three times.

	Mean
6 Male	41.83 y.o.
6 Female	38.83 y.o.

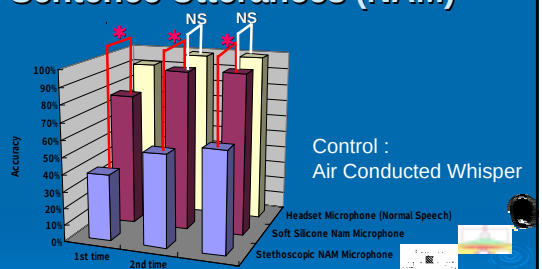
Code	Sensing Device	Sampling Rate
■NA_ST_08 NAM	Stethoscopic NAM Mic	8KHz
■NA_ST_16 NAM	Stethoscopic NAM Mic	16KHz
■BT_ST_08 BTOS	Stethoscopic NAM Mic	8KHz
■BT_ST_16 BTOS	Stethoscopic NAM Mic	16KHz
■NA_OC_08 NAM	Soft Silicone NAM Mic	8KHz
■NA_OC_16 NAM	Soft Silicone NAM Mic	16KHz
■BT_OC_08 BTOS	Soft Silicone NAM Mic	8KHz
■BT_OC_16 BTOS	Soft Silicone NAM Mic	16KHz
■WS_HS_08Whisper	Headset Mic	8KHz
■WS_HS_16Whisper	Headset Mic	16KHz
■NS_HS_08 Normal Speech	Headset Mic	8KHz
■NS_HS_16 Normal Speech	Headset Mic	16KHz

Sampling Rate and Aural Comprehension Accuracy



	Stethoscopic NAM Microphone (NAM)	Soft Silicone NAM Microphone (NAM)	Stethoscopic NAM Microphone (BTOS)	Soft Silicone NAM Microphone (BTOS)	Headset Microphone (Whisper)	Headset Microphone (Normal Speech)
□ 8KHz	57.48%	89.10%	88.89%	96.79%	97.65%	95.30%
▨ 16KHz	45.51%	90.17%	83.33%	98.29%	95.94%	98.71%

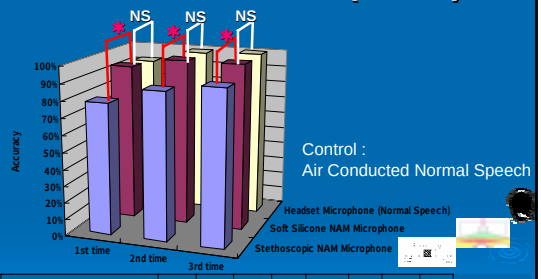
Aural Comprehension Accuracy of Sentence Utterances (NAM)



Control :
Air Conducted Whisper

NAM	1st	*	2nd	*	3rd	*	Total	*
Stethoscopic NAM Microphone	39.42%	14.82%	54.81%	15.75%	60.26%	14.09%	50.68%	8.45%
Soft Silicone NAM Microphone	78.20%	11.39%	94.87%	5.82%	95.83%	5.41%	88.86%	4.83%
Headset Microphone (Whisper)	91.67%	5.91%	99.04%	1.51%	99.68%	0.78%	96.68%	2.14%

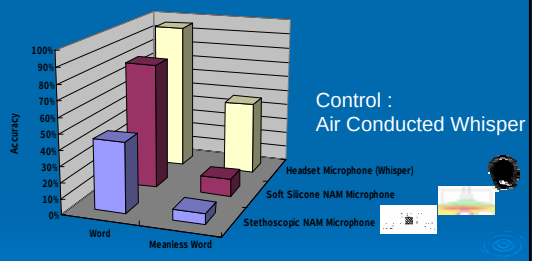
Aural Comprehension Accuracy of Sentence Utterances (BTOS)



Control :
Air Conducted Normal Speech

BTOS	1st	*	2nd	*	3rd	*	Total	*
Stethoscopic NAM Microphone	78.52%	12.24%	87.82%	9.40%	91.99%	6.17%	85.58%	5.44%
Soft Silicone NAM Microphone	93.91%	5.19%	99.36%	1.00%	99.36%	1.00%	97.35%	1.82%
Headset Microphone (Normal Speech)	91.99%	8.32%	99.03%	1.00%	100.00%	0.00%	96.85%	2.82%

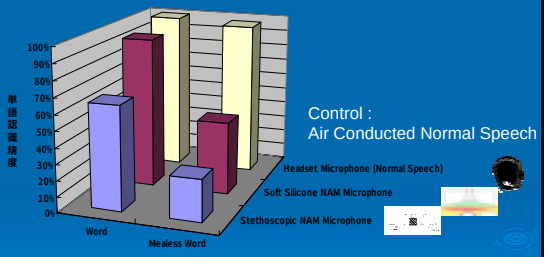
Aural Comprehension Accuracy of Single Word (NAM)



Control :
Air Conducted Whisper

	Word	Meanless Word
Stethoscopic NAM Microphone	44.44%	6.94%
Soft Silicone NAM Microphone	80.56%	11.11%
Headset Microphone (Whisper)	95.83%	47.22%

Aural Comprehension Accuracy of Single Word (BTOS)



Control :
Air Conducted Normal Speech

	Word	Mealess Word
Stethoscopic NAM Microphone	65.28%	26.39%
Soft Silicone NAM Microphone	94.44%	45.83%
Headset Microphone (Normal Speech)	100%	97.22%

Conclusion

- The bandwidth of the NAM microphone has improved by using soft silicon for the sound medium compared with stethoscopic type.
- The NAM microphone using soft silicon for the sound medium can sample expanding target voice signal by about 5-10dB and suppressing air conduction noise signal to low.
- The HMM recognition accuracy of NAM and BTOS has improved with soft silicon type NAM microphone compared with stethoscopic type.
- The catching sentences of NAM and BTOS accuracy by the person has improved with soft silicon type NAM microphone. However, the catching rate of a meaningless word was extremely low.

ABSTRACT: The bandwidth of the NAM microphone has improved by using soft silicon for the sound medium compared with stethoscopic type. With soft silicone type NAM microphones we can sample expanded target voice signal by 5-10dB, suppressing air conduction noise signal to low by the experiment of synchronous stereo sampling of air and flesh conducted voices at the same gain. The HMM recognition accuracy of NAM and BTOS has improved with soft silicon type NAM microphone compared with stethoscopic type. Aural comprehension test showed that accuracy of catching sentences of NAM and BTOS by 12 testee has improved with soft silicon type NAM microphone almost as high as that of air conducted voices. However, the catching rate of a meaningless word was extremely low.