

また、リモートマイクロホン内で無指向性マイクロホン技術を導入することより、指向性マイクロホン技術を使用する方が大きな利点を表しています。(Lewis *et al.*, 2004)。

2人で食事している場合、話し相手が1つのマイクを装着すればSN比が大幅に改善できます。ただし、複数の話し手が異なる時間で会話をしている場合、マイク1つのみで十分補聴できるとは言えません。

ワイヤレスマイクロホン ロジャーは、複数の話し手が装着しているそれぞれのマイクをマルチトーカーネットワーク経由で接続できます。De Ceulaer *et al.*ら(2016)は、人工内耳装用者におけるマルチトーカーネットワークの有用性について評価しました。彼らは、異なるSN比の環境下で複数のワイヤレスマイクロホンを使用すると、単一なマイクロホンより聞き取り能力が大幅に向上したことを発見しました。

複数のマイクロホンに接続したネットワークは、騒音環境下でのグループ会話にポジティブの影響を与えますが、このアプローチは意外なマイナス効果を引き起こす可能性があります。例えば、マイクロホンを多めに準備するためのコスト、話し手側がマイクロホン装着に対する否定的な異議の処理、聞き手側がマイクロホンに対してコントロールできないなどの状況が生じた場合、人によって不快感があるかもしれません。

こういった異論に対して、下記の対処方法で簡単に解決できます。それは、マイクロホンをテーブルの中央に配置することにより複数の話し手の会話音をピックアップし、語音弁別を改善できることです。グループ会話用に設計されたフォナック ロジャー セレクト (Gigandet, Fulton, & Smith, 2018)を例として説明しますと、3つの無指向性マイクが三角形構成でセレクトに配置され、そのおかげで適応指向性マイクシステムが構成できます。また、このマイクロホンはマルチビーム技術を使用し、最高のSN比を持つスピーカーに基づいて、アクティブ化する最適なビームを自動的に選択します。更に、聞き手は1つ或は複数のビームを手動で選択することにより自由にマルチビームマイクの動作をコントロールできます。それによって1名或は複数の話し手との会話を両方楽しめます。

ロジャー セレクトは、1つのワイヤレスマイクロホンとして小グループ会話で使用できますし、より低いコストで実現できるマルチトーカーネットワークになるかもしれません。

この研究の主な目的は、ロジャーペンまたはロジャーセレクトを単一のリモートマイクとして使用する場合と、グループリスニング環境でリモートマイクを使用しない場合の、騒音下での音声認識の潜在的な利点を比較することでした。 remote

Methodology

Participants

Ten participants between the ages of 20 and 92 with bilateral sensorineural hearing loss took part in the study. Eight participants wore bilateral hearing aids (HA). The pure-tone audiogram of the better ear for the participants wearing hearing aids, can be seen in figure 1. Two participants had cochlear implants (CI) one was unilateral and the other was bilateral. All participants had more than two years of amplification experience and half of the group had more than five years of experience with remote microphone technology.

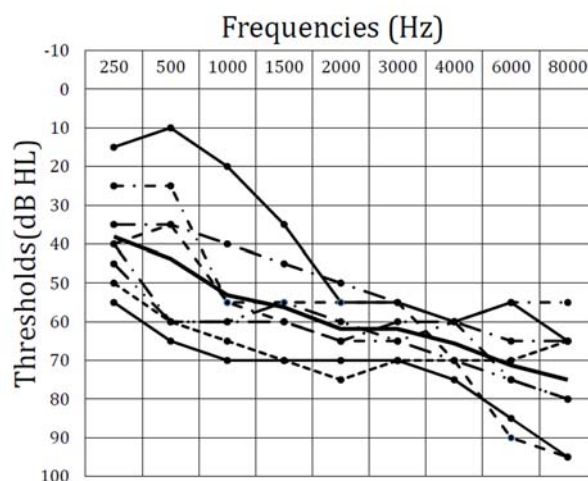


Figure 1. Pure tone audiogram of better ear for participants with hearing aids

Hearing technology

Six of the eight participants wearing bilateral HAs were fit with Phonak Naida V SP or UP with design-integrated Roger receivers. The remaining two participants used their own Phonak hearing aids with compatible design-integrated Roger receivers. All hearing aids were programmed and verified with real ear measures to NAL-NL1 targets (Byrne *et al.*, 2001). The two participants with cochlear implants used universal Roger X receivers attached via the euro adapter.

Two wireless remote microphones, Roger Select and Roger Pen, were used in different noise levels while speech recognition was measured in a simulated group setting.

Test set-up & procedures

Participants were asked to repeat HINT sentences (Nilsson, Soli, & Sullivan, 1994) in noise, and speech

recognition was measured as a percent correct score in three different listening conditions:

- HA or CI alone
- HA or CI + Roger Pen
- HA or CI + Roger Select

In each of these listening conditions, speech was presented randomly from one of the five speakers (figure 2). Speech was held at a constant 65 dB A measured at the location of the participant while restaurant noise levels were adjusted to create four signal-to-noise ratios of +5, 0, -5 and -10 dB to simulate a group dining experience.

For the listening situations where the remote microphones were used, a single Roger Select or Roger Pen was placed in the center of a table while participants listened via their wireless Roger receivers.

To evaluate the effect of individuals raising their voices in background noise, an additional speech recognition measurement was conducted. Speech was presented at 70 dB A at the highest noise level of 75 dB A and speech recognition was again measured in the three listening conditions.

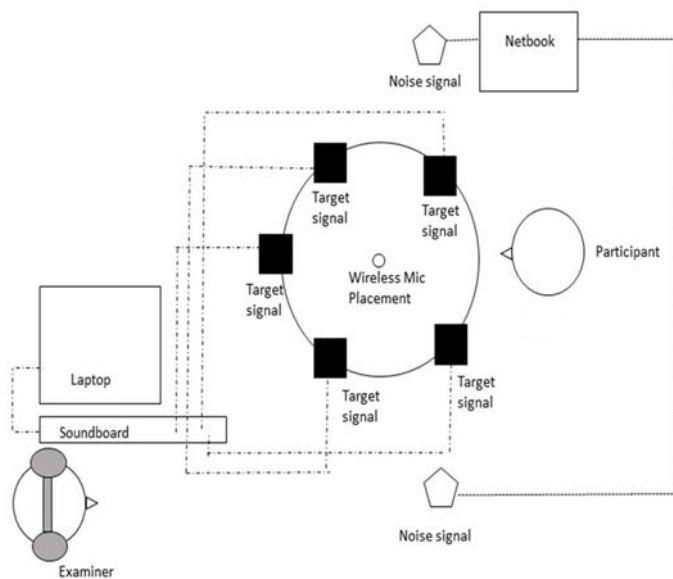


Figure 2. Test set-up – the target signal (speech) was randomly presented at a constant 65 dB A level while restaurant noise was presented at 90° and 270° and adjusted to different SNRs

Results

The effects on speech recognition in different listening conditions and between microphone technology and noise level are shown in Figure 3.

Following arcsine transformation, the data were analyzed using a two-way, repeated-measure ANOVA for the four noise levels and three listening conditions. There was a significant main effect for microphone technology ($df = 2$, $p < .0001$), noise level ($df=3$, $p < .0001$), and a significant interaction ($df=6$, $p < .05$) demonstrating the impact on speech recognition in the different listening situations in noise.

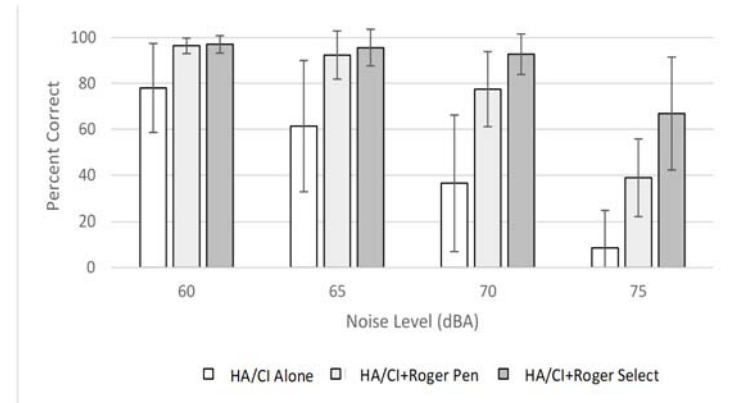


Figure 3. Mean HINT sentences scores across noise levels vs listening condition

Figure 4 shows the benefit in speech recognition from the two wireless remote microphone technologies comparing the listening situation with speech presented at 70 dB A (-5 dB SNR) vs speech presented at 65 dB A (-10 dB SNR) in 75 dB A noise. The results in the -5 dB SNR condition demonstrate participants performed an average of 61% better with the Roger Select and an average of 45% better with the Roger Pen than with HI or CI alone.

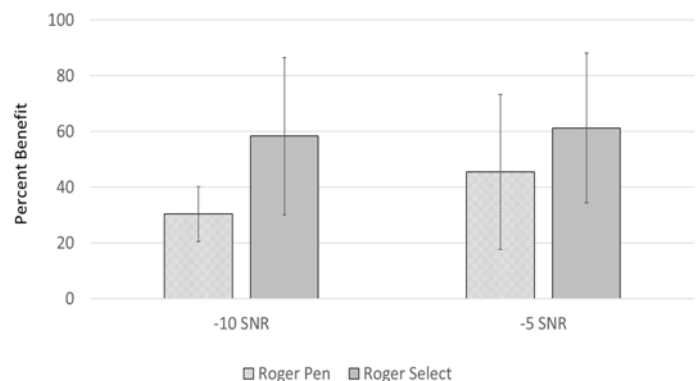


Figure 4. Average benefit in HINT sentence scores when using remote microphone technology at -5 and -10 dB SNR in 75 dB A noise. Benefit was determined by subtracting the score from the HA or CI alone from the score when the remote microphone was used.

Conclusion

Despite significant advancements in amplification technology, adults with hearing loss still encounter difficulties communicating in noise, especially where multiple speakers are present. The focus of this study was to evaluate the potential benefits in speech recognition in noise for two different types of remote microphone technologies – Roger Select and Roger Pen – compared to the use of a hearing aid or cochlear implant alone in a multi-talker situation.

When using the adaptive remote microphone technology in Roger, participants experienced an average improvement in speech recognition in noise of up to 61% with the Roger Select and up to 45% with the Roger Pen compared to the use of a hearing aid or cochlear implant alone. Therefore, these results demonstrate that the introduction of remote microphone solutions address the challenges which adults with hearing loss face in dynamic listening situations. These remote microphones are capable of significantly improving speech recognition in noise and minimizing the social barriers when there are multiple speakers present.

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