The Effect and Interaction of Hearing Aid Technologies on Listening Effort

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INTRODUCTION

❖Listening effort is emerging as an important hearing aid outcome domain.
- Individuals with hearing loss have difficulty understanding in a variety of listening situations, especially in background noise

❖People with hearing loss also expend more listening effort than their normal-hearing peers.
- ❖This results in greater fatigue due to listening.
- ❖ It has been shown that hearing aids may alleviate listening effort for individuals with hearing loss.

❖Previous research (Wu & Stangl, 2013) suggests that Wide Dynamic Range Compression (WDRC) processing may have a detrimental effect on acceptable noise level when compared to linear processing, indicating that hearing aids using WDRC are noisier than hearing aids using linear processing.
- ❖Digital noise reduction (DNR) was shown to offset this effect.

❖The objective of the present study is to investigate how WDRC, DNR, and their combination impact listening effort in adults with hearing impairment. It is hypothesized that WDRC will increase listening effort when compared to a linear processing strategy, and that DNR will offset this effect.

METHODS

❖Participants
- ❖Twenty-five adults with hearing impairment
- ❖Participants were fit with commercially available receiver-in-the-canal (RIC) hearing aids bilaterally using real-ear measurements according to NAL-NL2 targets.

❖ Procedure
- ❖Dual-task paradigm wherein the participants performed a primary speech recognition task simultaneously with a secondary visual reaction time task in both a +8 and +2 dB signal-to-noise ratio (SNR).
- ❖The Institute of Electrical and Electronics Engineers (IEEE) sentences (IEEE, 1969) were used as the primary speech recognition task stimulus. 40 sentences were presented in each hearing aid condition and each SNR.
- ❖At the end of each condition, participants were asked to give a subjective rating of listening effort from 0 (very easy) to 100 (very difficult).

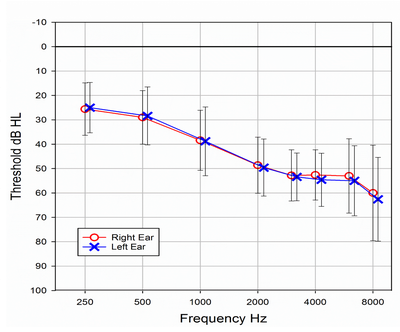

Fig. 1. *Mean audiometric thresholds for 25 participants.*

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METHODS

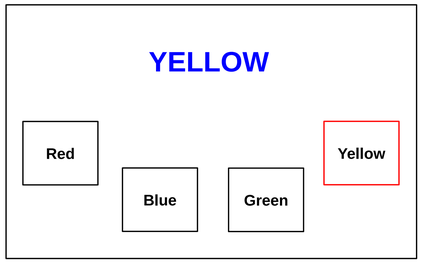

Fig. 2. *Reaction time task.* The stimulus for the simple reaction time (RT) task is shown above. Participants were instructed to press the space bar on a keyboard as soon as the large word appeared on the screen.

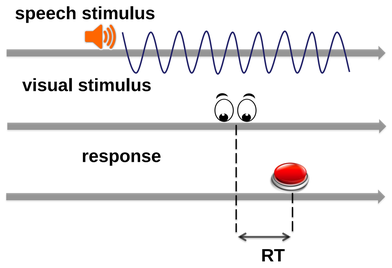

Fig. 3. *Schematic illustration of the dual-task paradigm.* Participants were instructed to repeat the speech stimulus as accurately as possible after responding to the visual stimulus.

RESULTS

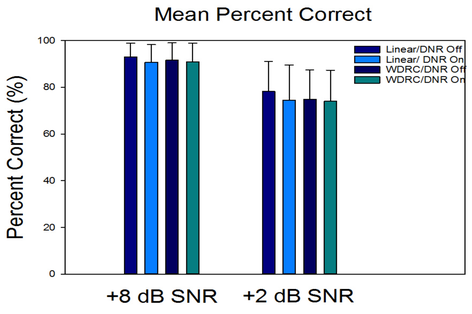

Fig. 4. *Mean speech recognition scores.* Mean percent correct for the speech recognition task is shown for each hearing aid condition in the +8 dB and +2 dB SNR.

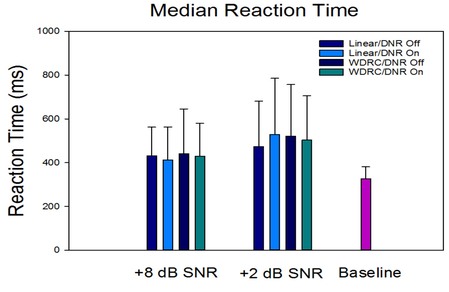

Fig. 5. *Median reaction time.* Reaction time was defined as the time between when the visual stimulus was presented and when the subject pressed the space bar on the keyboard. Baseline reaction time is shown in pink and was obtained using the visual stimulus and background noise only.

RESULTS

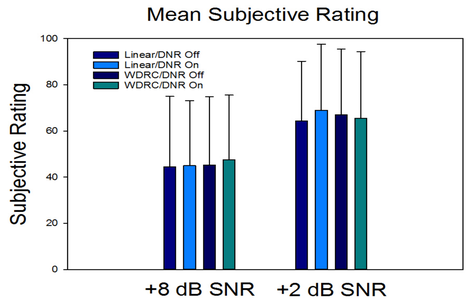

Fig. 6. *Subjective rating.* Participants were asked to rate difficulty of listening on a scale from 0 (very easy) to 100 (very difficult). Mean subjective ratings are shown for each hearing aid condition and each SNR.

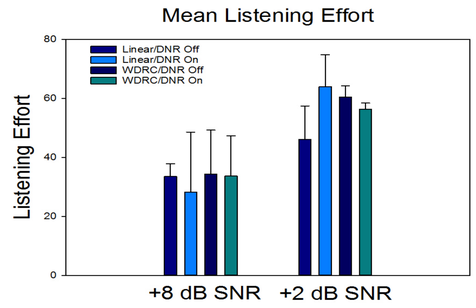

Fig. 7. *Mean listening effort.* Listening effort was calculated as [(test RT – baseline RT)/(baseline RT)] x 100%. A repeated measures ANOVA revealed a significant effect of SNR on listening effort. Compression and DNR did not have a significant effect in the +8 dB SNR condition. At +2 dB SNR, a significant interaction between compression status and DNR was observed.

CONCLUSIONS

❖SNR has a significant effect on listening effort (increased in poorer SNR).
❖WDRC and DNR have no effect on listening effort in the +8 dB SNR condition.
❖The effect of WDRC and DNR in the +2 dB SNR condition is unclear.
- **❖When DNR is off, WDRC is detrimental to listening effort.**
- **❖In the WDRC mode, listening effort is smaller for DNR-on than DNR-off, but the difference is not significant**

❖The simple reaction time task may not be a sensitive measure of listening effort, so more research with a more difficult secondary task is needed.

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