

Phonak

Field Study News.

Empowering adolescents with Dynamic Noise Cancellation and Tap Control.

A study conducted at Vanderbilt University evaluated the benefit of activating Dynamic Noise Cancellation (DNC) with adolescents' hearing aids. The study concluded that speech intelligibility was consistent across various DNC settings. Additional findings indicate that having access to the DNC settings via the myPhonak and myPhonak Junior apps can positively influence anxiety in noisy environments, and that Tap Control is an easy and appealing option for accessing Bluetooth®.

Standaert, L. & Nelson, J., conducted by Erin Picou et al at Vanderbilt University, February 2024

Key highlights

- Speech intelligibility is maintained regardless of the DNC setting.
- The majority of participants reported feeling more confident knowing they could personalize their noise reduction settings.
- Ability to adjust DNC settings via the app was found to reduce anxiety for most participants who reported feeling anxious in noisy situations.
- Participants reported a reduction in listening effort when DNC was engaged on the "Strong" setting as compared to the "Off" setting.

Considerations for practice

- Consider setting the feature to "weak" as a default for pediatric fittings, and encourage adolescents to use the app accordingly. In noisy environments, participants, on average, set the DNC slider to a moderate position on the app.
- Adolescents like being able to change DNC with the app at their convenience, and may feel more empowered when able to control selected hearing aid settings.
- Activate Tap Control and provide a brief training. All participants were able to use Tap Control and the majority preferred Tap Control to access Bluetooth streaming over hearing aid and phone controls.

Introduction

Advanced hearing aid features, such as noise reduction and directional microphones have traditionally been developed primarily for adult hearing aid users, while pediatric fittings have focused on providing as much audibility as possible by way of omni-directional microphones and minimal noise reduction. However, recent literature supports enabling advanced features for some younger users (McCreery, et al 2012; McCreery, et al 2010; Stelmachowicz, et al 2012; Beck, 2014; Pittman, 2011; Specifically, Wolfe, et al, 2022; Wolfe, et al, 2017) found that adaptive noise management could be beneficial to school age and older children. Additional research has shown that this population is capable of adjusting noise reduction appropriately when given access to an app which allows for real time adjustment (Bohnert, et al, 2023; Standaert, 2021).

Dynamic Noise Cancellation (DNC) is a spatial noise cancellation feature that works in combination with the adaptive directional beamformer and can provide up to a 4 dB signal to noise ratio SNR improvement. This feature can be enabled and adjusted via Target Fitting Software, but it can also be adjusted by the patient via the myPhonak and myPhonak Junior apps.

We know that adolescents can benefit from the improved sound cleaning that noise reduction can offer, but it is unknown if the option to self-adjust DNC could have other benefits as well, such as increased confidence, reduced anxiety, or self-perceived reduced listening effort. A study conducted at Vanderbilt University Hearing Research Lab evaluated these three outcomes, along with speech understanding, with different levels of DNC, as well as adolescents' ability and preference to use Tap Control.

Methodology

Eighteen participants, aged 10-17, were recruited for this study. There were 9 males and 9 females, and all were hearing aid owners. All participants were fit with the Phonak Audeo™ Lumity 90 RIC, and either M or P receivers, per Target Fitting Software, and Target recommended domes. Participants were given access to the myPhonak app version 6.3 which was installed on either their own personal smartphones, or a lab-issued loaner phone.

This study included three lab visits and two home trials. The first lab visit consisted of the hearing aid fitting, verification, and training on the use of the app. Participants listened to a story (70 dBA) presented at 0 degrees azimuth, while diffuse noise (68 dBA) was presented from four corner speakers. These levels of speech and noise lead to a Speech in Loud Noise

classification in the hearing aids. As they were listening, they were instructed to adjust the Speech Focus slider on the app (i.e., the DNC adjustment) to hear the differences in the speech at different slider positions. Once they were acclimated to the function of the slider, they created and saved a custom setting to their liking. The participants used this setting as a baseline for any further adjustments they created during the first home trial. Additionally, this visit included an A/B comparison of the DNC settings of "off", "weak", and "strong". Each comparison ("off" versus "weak", "off" versus "strong", "weak" versus "strong") was presented six times for a total of 18 trials.

The second lab visit included a questionnaire about their use and preference for the Speech Focus slider, and whether the ability to adjust the noise reduction affected how they felt in noise (i.e., anxiety and confidence ratings) during their home trial. The questions were rated using a 5-point scale, with 1 being the least favorable score and 5 being the most favorable score. That is, 1 = "I feel a lot less confident" or "I feel a lot more anxious" whereas 5 = "I feel a lot more confident" or "I feel a lot less anxious".

The participants listened to the story in noise again, adjusted the slider to their preference, and saved this setting as a custom setting in the app. They then completed a dual-task paradigm to measure self-perceived listening effort with DNC "off", "weak", "strong", and with the custom setting. This task consisted of a primary task of monosyllabic word recognition and repetition, and a secondary task of a physical response to a certain word category. Participants pressed a button when the word they heard was an object "bigger than a basketball". Following the dual task activity, participants were asked "How easy was that to listen to?" and used a rating scale from 0 (not at all easy) to 100 (very easy). For more information on this methodology, see Picou et al, 2017. The rating for the question ranged from 0 = not easy at all, to 100 = very easy.

Participants were then trained on the use of Tap Control using the training sequence option in Target. Their ability to use Tap Control appropriately was then assessed with three additional tasks outside of Target: pause/resume streaming, answer a phone call, and ask the voice assistant a question. Pass criteria consisted of 3/5 successful on the first attempt, and one additional correct after the second attempt (if needed).

During the second home trial, participants were encouraged to continue using the Speech Focus slider for noisy situations and to use Tap Control for streaming.

The final lab visit included a questionnaire regarding the ease of use for Tap Control for streaming music, answering phone

calls, and asking questions to voice assistant. They were also asked which method (Tap Control, pushing button on the hearing aid, or using phone control) they preferred to use for each task. Again, the questions were on a 5-point scale, with 1 being the least favorable, and 5 being the most favorable.

The image of the phone screen with the position of the slider on the app (i.e. the saved custom setting that was most used during the home trials) was captured, and the position of the slider was measured (in inches) using Adobe computer software and subsequently calculated to a percentage with DNC full-on equaling 100%, and DNC off equaling 50%.

This visit also included objective speech-in-noise testing using the adaptive HINT-C task. The hearing aids were programmed with four manual SPiN programs, each with a different DNC setting ("off", "weak", "moderate", "strong"). The order of the programs was randomized and participants were blinded to the condition. The word list was presented from the front speaker at variable levels, while diffuse cafeteria noise was presented from the four corner speakers at a level of 68 dBA. The SNR50 was calculated for each of the hearing aid programs.

Results

During the study and subsequent analysis, three outliers were identified. Two participants who had reported that they did not regularly wear their own hearing aids, and one participant who was not able to use the app during the home trial. The following results are based on the remaining fifteen participants.

Use & Preference of DNC adjustments

The A/B comparisons from the first lab visit proved inconclusive, as participants were inconsistent in their responses, especially when choosing between "weak" and "strong". Instead, an analysis of variance of the slider position (taken from the images captured in the final visit from the participants' phones) with between groups factor of preferred program in the A/B comparisons (DNC on vs. DNC off) was undertaken to determine consistency between their A/B preferences and their slider position in real world settings. The results were significant ($p = .04$) and showed those participants who preferred "off" or had no preference during the A/B comparison, preferred the slider position with DNC nearly off (average slider position at 60%). Participants who preferred DNC "on" during the A/B comparisons preferred the slider position to be at an average position of 82%, which correlates to a setting of "moderate". See Figure 1a and 1b.

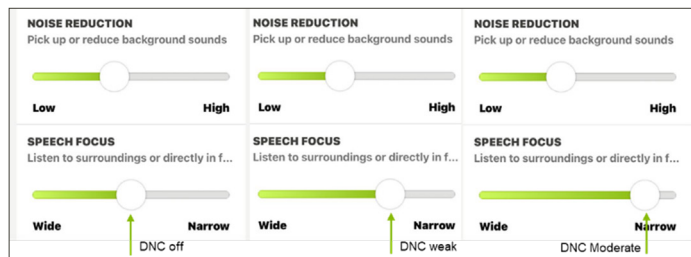


Figure 1a shows the Speech Focus slider positions which correlate to DNC "off" (left figure), DNC "weak" (middle figure) and DNC "moderate" (right figure). Compared to the 'off' position with the slider at 50%, DNC on "weak" shows the slider at approximately 60%, and DNC on "moderate" (right figure) shows the slider at approximately 82%.

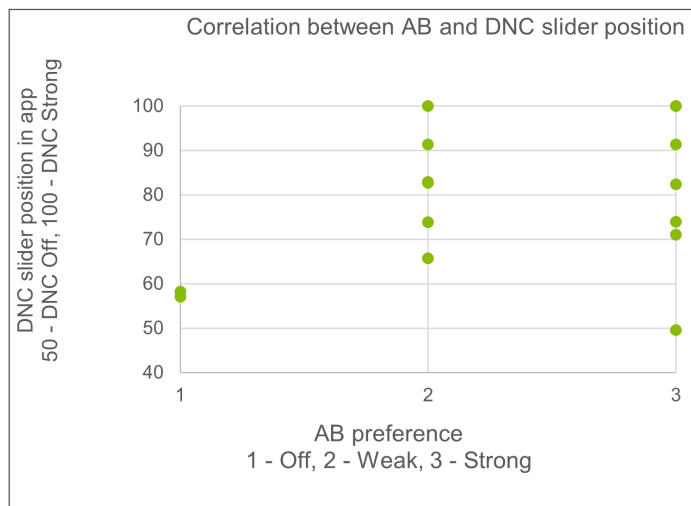


Figure 1b. The participants who preferred DNC off (1 on the x-axis) during the A/B comparisons also kept the slider position at a weak setting (below 60%), whereas most participants who preferred the DNC on at either "weak" or "strong" during the A/B comparisons (2 and 3 on the x-axis) kept the slider at ~65% or above during their home trial.

In response to the question, "Do you like being able to change the Speech Focus (i.e. DNC) slider with this app?", the majority of the participants (80%) responded positively. Additionally, when asked, 73% of the participants would use the app to adjust their noise reduction at least several times per week. Those who liked the app said it was easy to use and they liked being able to change it based on their current environment. Three participants (20%) did not like making adjustments through the app. One participant was not able to get the program to "sound comfortable or normal enough for my liking", while the two other participants preferred to be able to hear everything around them and felt they were more aware of their surroundings.

Anxiety & Confidence Questionnaire for DNC

The following results are based on seven participants who reported feeling either "a little anxious" or "very anxious" in noise prior to being enrolled in this study. Of these seven, six reported using the app made them feel less

anxious in noise, while one who reported feeling “a little anxious in noise” prior to the study felt no different with use of the app. This participant also stated they would need to “use it more to see how I feel”. See Figure 2 below.

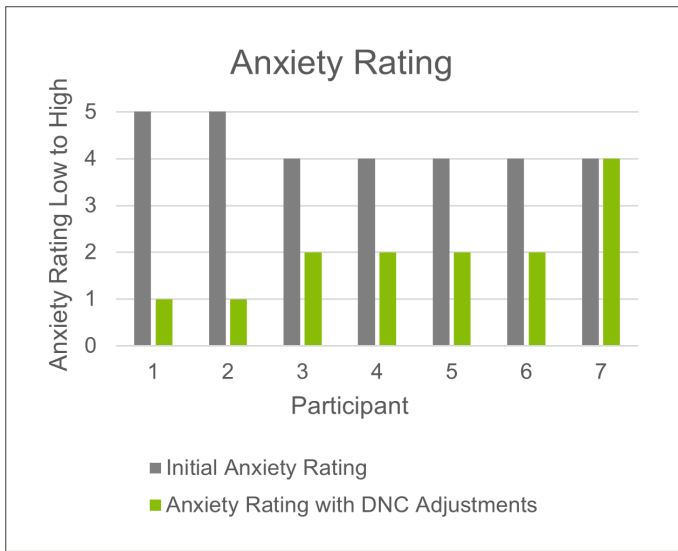


Figure 2. Anxiety in noise ratings before and after use of the DNC adjustments. Rating scale ranged from 1 = I feel very calm/ a lot less anxious in noise, 2= I feel a little calm/ a little less anxious in noise, 3 = I don't feel anxious or calm in noise, 4 = I feel a little anxious in noise/I feel a little more anxious in noise, 5 = I feel very anxious in noise/I feel a lot more anxious in noise.

These seven participants also reported feeling “a little more confident” or “a lot more confident” on the questionnaire which ranged from 1 = “A lot less confident” to 5 = “A lot more confident”. See figure 3.

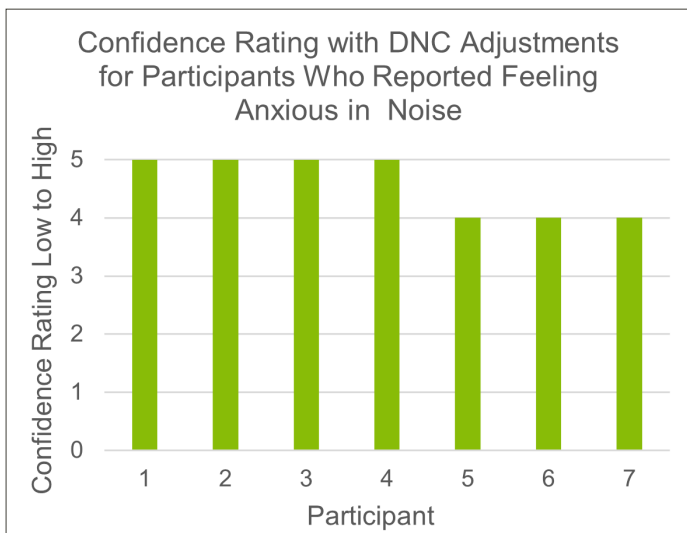


Figure 3. Confidence in noise ratings with use of the DNC adjustments for the seven participants who reported feeling anxious in noise prior to being enrolled in this study. Rating scale ranged from 1 = I feel a lot less confident in noise, 2= I feel a little less confident in noise, 3 = It didn't change my confidence 4 = I feel a little more confident in noise, 5 = I feel very a lot more confident in noise.

Two participants who reported feeling calm in noise reported feeling a “little more anxious” in noise with the use of the app. One participant stated that “When I messed with the Speech Focus too much it would mess with my surroundings and I'd not be able to make out what was happening around me”, while the other participant echoed the feeling of not being able to hear people talking “behind me and sometimes around me”. One participant who reported not feeling anxious in noise stated that the app did not change the way they felt in noise, but “understanding and focus was improved”.

Self-perceived Listening Effort

Participants answered the question “How easy was that to listen to?” following the dual task testing, and rated each setting on a scale from 0 (not at all easy) to 100 (very easy). A linear mixed-effects model with a fixed factor of program and a random intercept of participant was used in the analysis which showed a significant difference in ratings. Post-hoc comparisons revealed ratings of effort were better with “strong” than with “off” ($p < .05$) and better with “strong” than with “weak” ($p < .01$). See figure 4 below.

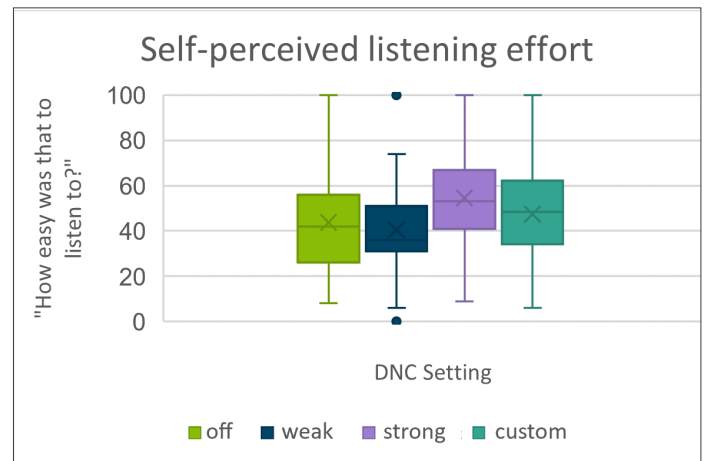


Figure 4. Subjective ratings of ease during the dual task for different DNC settings. The rating scale ranged from 0 = not at all easy to 100 = very easy. Linear mixed-effects analysis showed significant differences between “off” and “strong” and “strong” and “weak”.

Speech Intelligibility in Noise

The mean dB SNR for the DNC conditions "off", "weak" "moderate" and "strong" were very similar. Data analysis revealed no significant differences between any of the DNC settings ($p = .296$). All dB SNR levels were between 1.01 and 1.02.

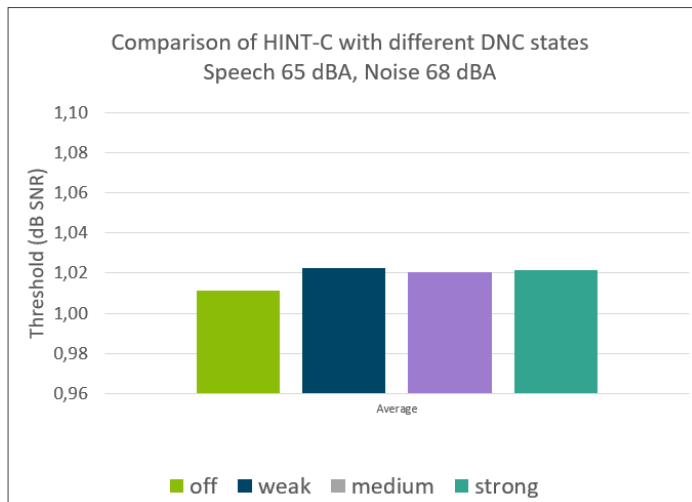


Figure 5. Comparison of dB SNR for different strengths of DNC.

A data extrapolation was performed on the HINT-C data for the DNC "weak" condition only on ages 0-9, in accordance with the FDA's data extrapolation guidance. The results revealed a low probability that younger children would perform worse than older children, and there is a low probability that the "weak" setting would affect speech recognition performance. Combined, these results suggest that there would be no speech-in-noise intelligibility consequences of enabling DNC in a "weak" setting for children between 0 and 18 years of age.

Tap Control Preference

100% of the participants were able to successfully use Tap Control either the first time after training, or after one additional, brief re-instruction in the lab. One participant did not use Tap Control or the app/phone to access streaming, phone calls during the home trial, and one participant reported that it was "a little hard" to use because it did not always work.

Compared to using their phone controls, the majority of participants (60%) preferred to use Tap Control for streaming, as opposed to using the phone controls, while about half of the participants preferred to use it for answering phone calls (53.3%).

Conclusion

Key findings indicate positive effects were seen in subjective listening effort with DNC activated. Importantly, speech intelligibility was maintained, no matter the DNC setting. All of the participants in this study were able to use the Speech Focus slider for DNC adjustments, and the majority liked the option to personalize their noise reduction settings. When using the app, participants who reported feeling anxious in noise reported they were less anxious and felt confident. As a result of these key findings, pediatric HCPs can feel confident setting the default DNC to "weak" for their pediatric patients of all ages.

In addition, this population found it easy to use Tap Control, and whether they prefer Tap Control or their phone app to access streaming and make phone calls, this is a feature that should not be restricted to only adult patients.

In summary, HCPs can feel comfortable and confident in enabling DNC and Tap Control with their adolescent patients. Engaging in a discussion with both the patient and their caregivers about the additional use of the app and/or the Tap Control feature may further empower the adolescent in their hearing journey.

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