New clinical evidence

Reducing sustained listening effort and listening stress with Oticon Intent™

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Valentina Zapata-Rodríguez and Sébastien Santurette
Centre for Applied Audiology Research, Oticon A/S

Summary
Oticon Intent with 4D Sensor technology seamlessly adapts the amount of listening support based on the user's listening needs. In this study, we used a novel experimental approach with virtual reality where participants could turn freely to locate a target talker and then solve a speech comprehension task. We evaluated the effectiveness of the 4D Sensor technology in Oticon Intent in reducing listening effort and listening stress compared to Oticon Real™. We found an up to 31% reduction in mean pupil size and a 40% reduction in mean heart rate for Oticon Intent when compared to Oticon Real. These results indicate significantly lower sustained listening effort and listening stress, respectively. Oticon Intent thus helps users feel more engaged during conversations in challenging listening environments.

Introduction

Understanding speech in noisy environments is the number one challenge for people with hearing loss. In natural settings, identifying and focusing on a talker among several competing sound sources is essential for engaging in conversation. Oticon Intent with 4D Sensor technology predicts the user's listening intent and adjusts the listening support accordingly. Here, we used virtual reality (VR) to test the BrainHearing™ benefits of Oticon Intent in terms of listening effort and listening stress during a speech comprehension task that was preceded by a localization task[1].

DID YOU KNOW?

MoreSound Intelligence™ 3.0 surpasses traditional technology by adapting support levels based on user intention. Powered by 4D Sensor technology, Oticon Intent predicts user listening intentions by combining insights from motion and acoustic sensors, while the upgraded Deep Neural Network (DNN) 2.0 ensures superior noise suppression. Further details on the BrainHearing™ benefits of the 4D Sensor technology can be found in Bianchi/Eskelund et al. (2024)[6].

Sustained listening effort

Objective listening effort is often assessed through pupillometry, which monitors changes in pupil size during listening tasks. Greater pupil dilation indicates increased listening effort during sustained listening tasks that require continuous attention and engagement[2]. Sustained listening effort refers to the prolonged mental effort required to maintain attention and engagement in real-life listening situations, like following a long conversation[3].

Listening stress

Listening stress can be observed by changes in heart rate in response to variations in the listening environment[4]. Elevated heart rate indicates higher stress levels. Listening stress is often linked to listening effort: increased effort caused by noise can lead to distress[5]. Therefore, when effective hearing assistance is provided to mitigate the effects of unwanted noise, listening stress can be reduced. This phenomenon is also observed in daily life where individuals tend to have higher heart rates when exposed to noise while listening to speech[4].

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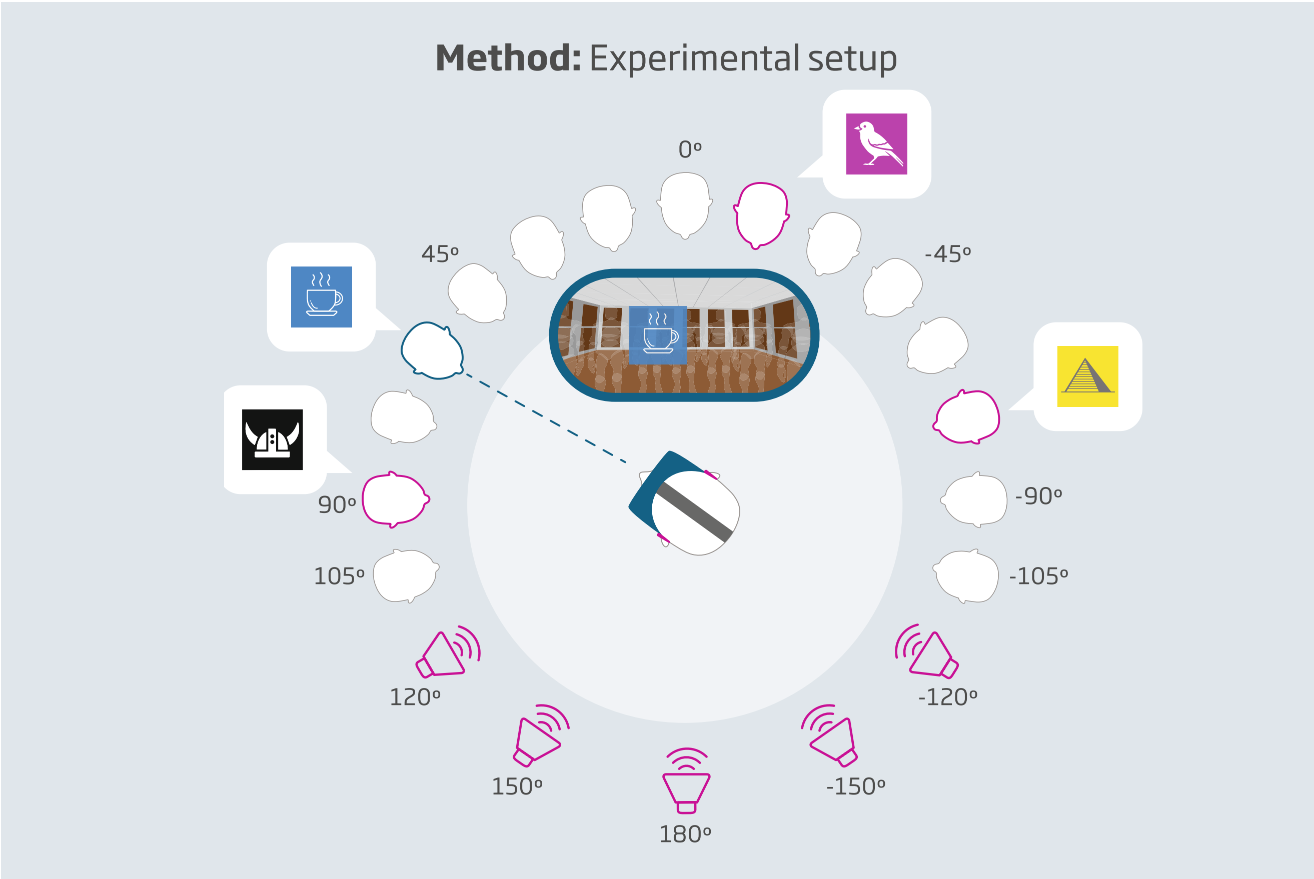

Figure 1. Example of a test trial for a very complex listening situation (4 competing talkers). Here, the participants first had to move around to locate the person talking about coffee (indicated by the icon). Once they selected and oriented themselves to the correct talker, they had to focus on that talker for 33 seconds and follow their speech while we monitored their changes in pupil size and heart rate.

Experimental setup

- VR and room acoustic simulations were used to create naturalistic virtual audiovisual scenes[1].
- Fifteen visual avatars were located horizontally with stationary background noise presented from the back.
- 2 scenes were evaluated: complex (with two competing talkers) and very complex (4 competing talkers).
- Each experimental trial had a different combination of locations for the competing talkers among the 15 visual avatars.
- Each competing talker as well as the background noise were presented at 60 dB SPL.
- Pupil dilation was continuously recorded by the VR goggles and the heart rate was recorded with a wristband.
- Oticon Intent and Oticon Real, were both fitted with default settings, individual audiograms, and VAC+ fitting rationale.

Participants

- Experienced hearing aid users (pupillometry: N = 25, heart rate: N = 20) with symmetrical, mild-to-moderate sensorineural hearing loss.
- Mean age 68 years, range 48-82.

Task

- Participants had to orient in the sound scene and locate the person talking about a specific topic based on a visual cue. Then, they focused on the identified talker while a newsclip was played from that location.
- Speech comprehension was assessed with a yes/no question concerning the content of the newsclip.
- This test simulates a common listening scenario: being at a dinner or party with multiple concurrent conversations in a noisy environment. You first need to select and locate the conversation you want to join, then position yourself well to focus and engage in an intimate conversation.

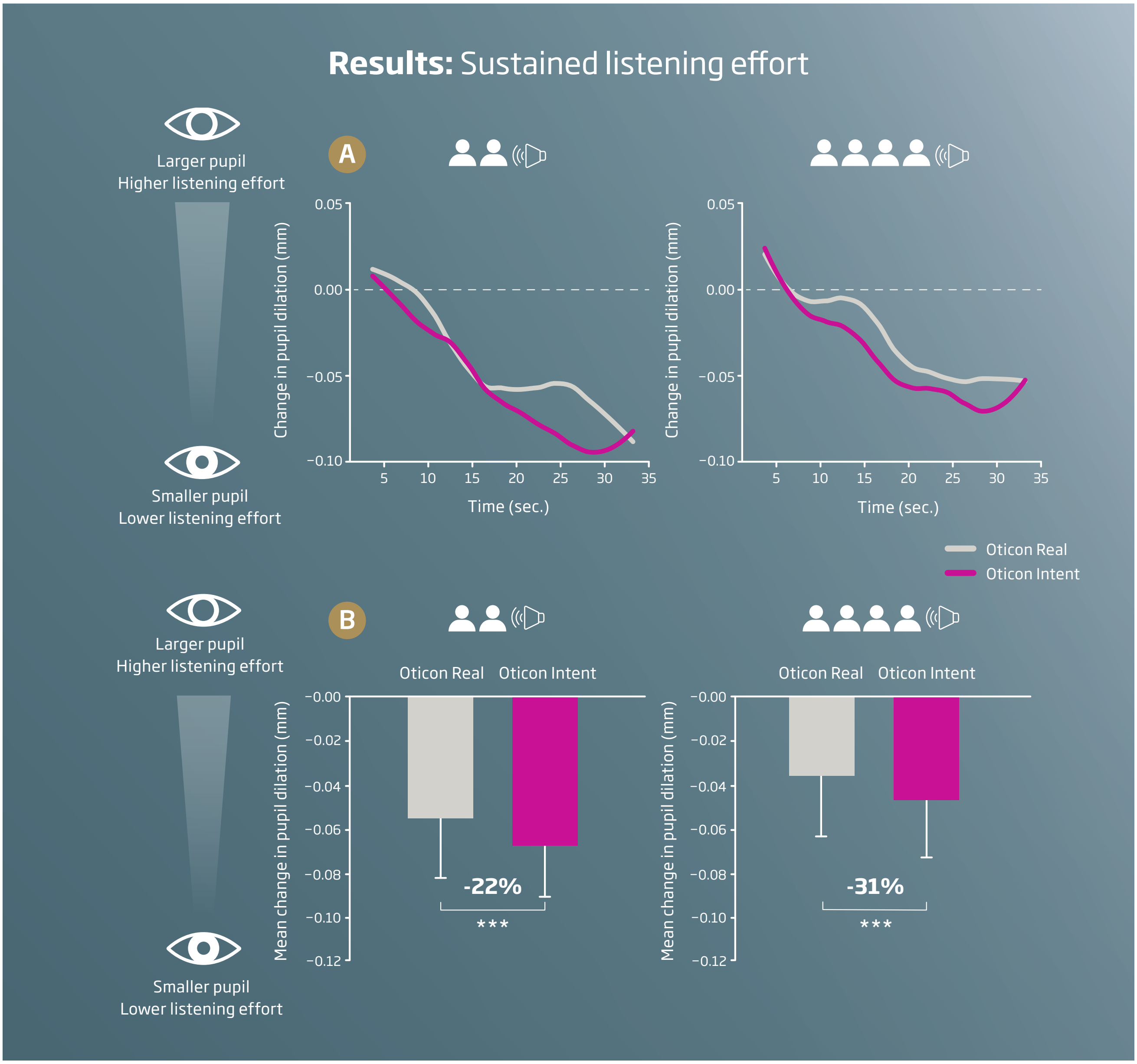

Figure 2. A: Change in pupil size with Oticon Intent and Oticon Real over 33 seconds of speech comprehension for a complex (left) and a very complex (right) listening situation. B: Mean pupil size across participants and time with Oticon Intent and Oticon Real. Significant differences are indicated with an asterisk (= p<0.05, ** = p<0.01, *** = p<0.001). Error bars represent standard error of the mean (SEM)..*

- Figure 2A shows the change in pupil size with Oticon Intent vs Oticon Real over the course of the speech comprehension task. For both complex and very complex listening situations, a general reduction in pupil size with Oticon Intent indicates that sustained listening effort and engagement are improved during the focused listening state.
- Figure 2B shows that Oticon Intent provides a 22% reduction in listening effort when the listening environment is complex, and a 31% reduction when the listening environment is very complex, compared to Oticon Real. This is based on a significant relative reduction in mean pupil size.

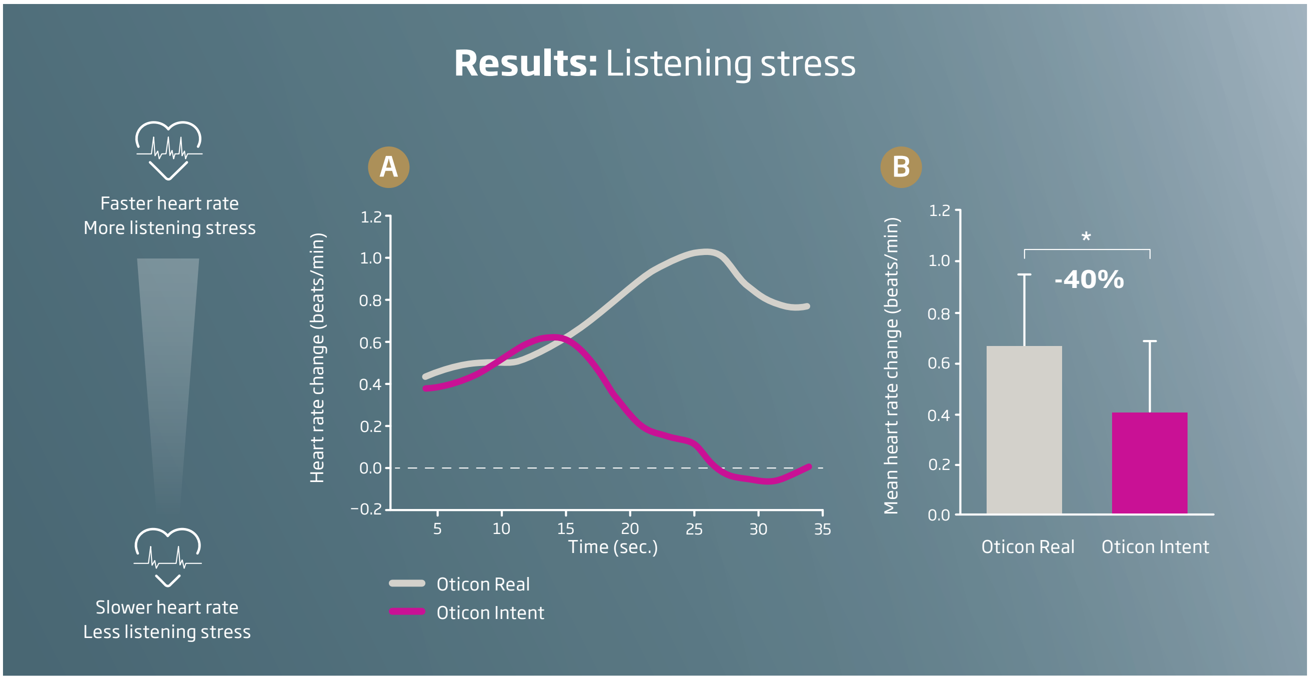

Figure 3. A: Mean heart rate change (beats/minute) with Oticon Intent and Oticon Real over 33 seconds when increasing sound scene complexity from 2 to 4 competing talkers. B: Mean heart rate change across me with Oticon Intent and Oticon Real. Significant differences are indicated with an asterisk (= p<0.05, ** = p<0.01, *** = p<0.001). Error bars represent standard error of the mean (SEM).*

- Figure 3A shows the average change in heart rate (in beats/minute) between a complex and a very complex sound scene over the course of the speech comprehension task. The change in heart rate is significantly less prominent with Oticon Intent than with Oticon Real overall. At the beginning of the task, the change in heart rate is similar for both hearing aids. However, when the active listening part begins (after a few seconds), the heart rate with Oticon Intent decreases down to a point where it is comparable to the heart rate during speech comprehension in the less complex sound scene. This indicates that the listening stress caused by increasing sound scene complexity (number of competing talkers) is less prominent with Oticon Intent than with Oticon Real.
- Figure 3B shows that Oticon Intent provides a 40% reduction in listening stress compared to Oticon Real, based on a significant relative reduction of heart rate when increasing the sound scene complexity. This indicates a new BrainHearing benefit* of the superior listening support provided by Oticon Intent in very complex listening situations.

** Speech comprehension was similar between devices in both complex and very complex situations. Therefore, the results presented for sustained listening effort (Figure 2) and listening stress (Figure 3) indicate changes in the cognitive load required to complete the tasks.*

CONCLUSION

Oticon Intent with 4D Sensor technology and the new DNN 2.0 provides increased support in noise to hearing aid users in complex and very complex listening situations, resulting in a reduction of up to 31% in listening effort and 40% in less listening stress. Hence, Oticon Intent frees up cognitive resources for users to engage in conversations and in life like never before.

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