

# Fitting gently and counselling with data - personalising your clients hearing aids to meet their needs

## Oticon Optimal Fitting Series No. 4 - 2023 updates

### INTRODUCTION

More than 500.000 times per day, a hearing aid user may need their hearing aids to handle sounds differently. Previously, we have thought of transient handling features as meant only for loud sudden sounds, like a door slamming. In this paper, we introduce how you can use the feature SuddenSound Stabilizer to balance soft and loud sudden sounds of everyday life. With this introduction, we widen the use of this feature tremendously, because it can also be used to handle the soft sudden sounds of life (keys rattling, keyboard tapping, pen clicking, clothes rustling). This requires a slightly different fitting mindset, and we will share how this new powerful tool in the Genie 2 fitting software can change how you can adjust sound for clients with certain types of complaints. Additionally, SuddenSound Stabilizer is specifically designed with a Max setting for people with hearing loss who have special sensitivities to sudden soft and loud sounds, such as co-existing hyperacusis, tinnitus, or other sound sensitivities.

A new function in Oticon Genie 2 allows the hearing care professional to do more data-driven counselling and treatment recommendations. It is now possible to see the amount of time the client spends in different types of environments, and to see the client's voice activity averages in conversation across simple, moderate and complex environments and over time. Guidance on how to use these tools in an effective way with clients when they return to the clinic for a follow-up visits is also provided.

- 01 Introduction
- 02 Why is SuddenSound Stabilizer a fitting game changer?
- 05 Expanding data logging in Oticon Genie 2
- 09 References

### EDITORS OF ISSUE

**Johanne Rumley & Pernille Aaby Gade**

*Clinical Research Audiologists*

**Susanna Løve**

*Director, Audiology Oticon*

*Centre for Applied Audiology Research*

## Why is SuddenSound Stabilizer a fitting game changer?

Have you ever shared stories with a fellow hearing care professional on why a hearing aid fitting didn't go well? Many of us are all too familiar with the situation where a new hearing aid user comes back with the hearing aid in a bag and places it on the desk to return it. Or the situation where you learn months or years later that a client never used the hearing aids you so carefully fitted - they ended up in the drawer.

Why? If we get an opportunity to ask our clients, they often talk about the sound being an issue. "I just couldn't get used to it", or "It was too loud/sharp/tinny/aggressive", or finally, "I heard all the sounds I didn't want to hear and none of the speech I was trying to hear". This doesn't mean they weren't supposed to wear hearing aids. Rather, we could not meet their new user needs by giving them a sound they could accept and adapt to. In this Oticon optimal fitting paper, we challenge the conventional thinking on how to adjust your clients' hearing aids when they come in with complaints about the sound of their hearing aid. The development of the SuddenSound Stabilizer feature has taught us that sudden sounds are not just loud and uncomfortable.

### Soft sudden sounds

As a matter of fact, the culprit for hearing aid users is often the soft sudden sounds. You heard right: soft sudden sounds. The world is full of them. They occur many thousands of times per day, and if you are a new hearing aid user, you might suddenly have access to them - and that access is not always welcomed with open arms! No one goes to get a hearing aid expecting that the keyboard tapping of their colleague will drive them crazy, or that their keys clinking together, footsteps, or even the crinkling of a stiff jacket can be bothersome. We have typically counselled our users that these are the sounds of life and that their brains need to get used to them over time. But we are asking our new users to get used to a lot - their own voice, music perception, all the sounds of life - and when they can't, our go-to adjustment is often Fine-tuning, in order to reduce the gain a bit.

### A balanced sound scene

SuddenSound Stabilizer should be your first line of defence and your alternative to reducing gain, which

can potentially affect access to speech. SuddenSound Stabilizer is a dynamic feature, meaning that it reduces and restores gain instantly for soft and loud sounds, as they occur throughout the day. Sudden sounds are not noises to get rid of. We need them because they are part of life and can be very important to hear. Therefore, the bigger task is to find the right balance of these common sounds. Cutlery and pen clicking might be comfortable for one hearing aid user, but intolerable or annoying for someone else. Our task is therefore to customize our fitting to accommodate both needs. SuddenSound Stabilizer has six adjustable settings in Oticon Genie 2, to allow for the necessary flexibility. For more information and evidence related to SuddenSound Stabilizer, see Santurette, Brændgaard, Wang, & Sun (2023).

### SuddenSound Stabilizer in Oticon Genie 2

When we asked 201 HCPs about the importance of fitting for sudden sounds, 76% reported being able to control the processing of sudden sounds is important in their decision about which hearing aid to fit. It is now possible to take them into account in Genie 2.

Sudden sounds can be individual (setting a glass on a table), or part of a bigger, more complex sound (hitting the badminton birdie in a busy sports hall). Regardless, how we react to these sounds can be vastly different. Most HCPs would agree that it is a goal to make sounds accessible to people with hearing loss, if we can do it in a balanced and natural way. Since soft and loud sudden sounds are desirable to give access to, they must be balanced using gain as the tool. Sudden sounds are, by definition, very brief, and thus, they are broad in frequency. When we apply gain or remove gain, the goal is to be extremely precise in the time domain. Therefore, we must use attack and release times that are instantaneous, so we do not accidentally remove other meaningful sounds, such as speech. SuddenSound Stabilizer is unique in its speed and precision, which allows us to apply it more strongly, if that is what the client needs, with no impact on speech.

The location of SuddenSound Stabilizer is quite deliberate. It is part of Fine-tuning, next to Gain Controls and Sound Controls, because this is easily accessible for the HCP when they are adjusting the hearing aids, based on client input.

The default setting is Medium, as shown in Figure 1 illustrating the six settings. Due to the impact this feature can have on a large group of everyday sounds, it makes sense to give the HCP a very versatile fitting tool that can handle varying user needs. The maximum gain reduction that can be applied by the system is 0 dB in Off, 10 dB in Low, 15 dB in Medium, 20 dB in High, 25 dB in Very high, and 30 dB in Max. This does not mean that this is applied for every sound. On the contrary, the feature takes the level of the sound into account and subjects each sound to the unique algorithm that calculates the appropriate amount of gain reduction needed in a given moment for a given sound. In this way, we achieve the right balance of soft and loud sudden sounds that fits into the rest of the sound scene, taking individual preferences into account.

### Fitting SuddenSound Stabilizer for new users

What do you adjust when your client says, “The sound is uncomfortable/too sharp/too loud/too much/overwhelming/the wrong sound”? In the section below, Asking the right questions, we give you some tips on questions you can ask to further understand what your clients mean to determine if they could be referring to sudden sounds.

SuddenSound Stabilizer works dynamically with the sound input, meaning, it only activates when a sudden sound is registered. The rest of the time, the feature is passively monitoring. This is in sharp contrast to overall gain, which is a more static adjustment. This means, it uses a rule for how much gain to apply, and it is applicable all the time. Before you adjust gain in Fine-tuning, you should clarify with your client, whether their complaint is related to an overall impression of the sound, or if it could reflect a reaction to how sudden sounds are handled in the hearing aid. Your fitting choices make a real difference in the overall everyday experience for your client.

### Recommended SuddenSound Stabilizer settings

When fitting a new user, one goal is to avoid overwhelming them with all the sounds that were not available before. The brain needs time to adapt to a new sound scene. Therefore, it is recommended to set SuddenSound Stabilizer in High at the first appointment. At the follow-up visit, it is recommended to decrease SuddenSound Stabilizer to Medium. Hereafter, conduct the “Soft sudden sound test” (below) and further ask the suggested questions, to determine if the client can handle the Medium setting or would benefit from staying in High. For more experienced users, the Medium setting is recommended as a starting point.

#### THE SOFT SUDDEN SOUNDS TEST

This is how you can test your client's sensitivity for sudden sounds, besides from asking the questions below.

1. Click a pen multiple times.
2. Type on a keyboard
3. Tap your fingernails on the tabletop.

Are these sounds uncomfortable to your client?  
Consider increasing the setting in SuddenSound Stabilizer.

### Fitting SuddenSound Stabilizer for clients with hyperacusis

SuddenSound Stabilizer is a functionality that should be seen as widely applicable and how it is set should be considered for all hearing aid users. That said, SuddenSound Stabilizer is particularly applicable for populations who have sound sensitivity. Hyperacusis, sound sensitivity, and decreased sound tolerance are close in meaning and refer to a perception of the sound environments as intense and adverse (Fagelson & Baguley, 2018). More specifically, hyperacusis is used

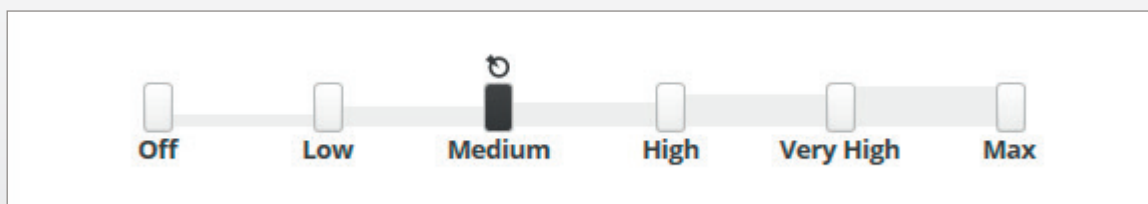


Figure 1. Screenshot of SuddenSound Stabilizer in Oticon Genie 2.

to describe intolerance to everyday sounds that causes distress and degradation in social, occupational, recreational, and other daily activities (Aazh, Moore, Lammaing, & Cropley, 2016). The sounds may be experienced as uncomfortable loud, unpleasant, frightening, or even painful.

### Recommended SuddenSound Stabilizer settings

Sound sensitivity is a common comorbidity with hearing loss and it is often described by people with tinnitus or recruitment as part of a sensorineural hearing loss. For this client group, the recommended starting point for SuddenSound Stabilizer is the High setting, especially if the client is also a new hearing aid user. For people with severe sound sensitivity, a successful hearing aid fitting requires extra precautions. For this population, we recommend setting SuddenSound Stabilizer to Max. However, please consider that Max is only recommended when other alternatives are not suitable and comfort is top priority, nevertheless, it is a good handle to have in your fitting toolbox.

Amplification may conflict with the client's belief that less sound is needed. However, SuddenSound Stabilizer may help the client in tolerating more sound, as sudden sounds are instantly balanced and reduced instead of overamplified. More sound is an aspect that the client might fear, thus it is important that the client buy-in on this approach. Counselling and transparency are key to help the client with hyperacusis tackle their sensitivity to and fear of hearing too much sound.

### Asking the right questions - to any client

Fitting for sudden sounds is your new clinical tool in your toolbox to optimise your clients' satisfaction with their hearing aids. A way to gain the necessary insights into your client's wishes, likes, and dislikes is to ask the right questions. The following are examples of questions that can elevate the conversation with your client - with or without sound sensitivity (inspired by Searchfield & Selvaratnam, 2018).



#### Problem and reaction

- *Are you often aware of sudden sounds in your environment?*
- *Do you have any sounds that cause discomfort or are unpleasant to you?*
- *What effect does the sound have on you?*

These questions provide an opportunity for your client to express the details of how they experience sudden sounds.



#### Discomfort

- *Do all sudden sounds cause discomfort? Are there specific sounds?*
- *Is it only when the sound is very loud or does it make you feel uncomfortable even if it is not loud?*
- *Do you have any idea why these sounds cause discomfort?*

These questions allow you to evaluate the effects of sound on your client and support the finetuning of SuddenSound Stabilizer. Additionally, for clients with sound sensitivity it is relevant to know if the effects are primarily related to the loudness, or if the sound sensitivity is more related to the intolerance or annoyance of sounds whether loud or not (Searchfield & Selvaratnam, 2018).



#### Situations or environments

- *Where are you when the discomfort occurs?*
- *Does the same sound always cause discomfort?*
- *How do your partner/family/friends react to the same sound? Are they supportive?*
- *Does it change if you are busy/having fun/experiencing stress?*
- *Are your work/home environments quiet?*

Asking these questions will give you information about the relation between sudden sounds and quiet or noisy environments. For example, a user may not want to wear his hearing aids in the office, simply because the keyboard clicks are too loud. For clients with sound sensitivity, involving their significant others is important. The HCP needs to know the effect of the sound sensitivity on the family and friends, among other things to establish when psychological referral is required (Searchfield & Selvaratnam, 2018).



#### Coping strategy

- *What do you do when the discomfort occurs?*
- *Do you limit yourself or your activities socially, and has this changed?*

With these questions, the HCP is helped to identify the existing coping strategies, for example not attending social events. If a coping strategy is maladaptive or unhelpful for the rehabilitation, the HCP can in a gentle way counsel on turning the behaviours in a more positive direction.



### Pleasant sounds

- *What are your favourite sounds?*

This question will end the conversation in a positive matter, focusing on the sounds that the client appreciates - like music. For clients with sound sensitivity, the goal is to find sounds that may be used in the rehabilitation process, where they are encouraged to increase exposure to more enjoyable sounds (Searchfield & Selvaratnam, 2018).

### Questionnaires

For people with sound sensitivity, a standardised questionnaire can be beneficial to conduct. The Hyperacusis Questionnaire includes 14 items and a scoring system from 0-42, where scores above 28 indicates strong auditory hypersensitivity (Khalifa et al., 2002). For rehabilitation purposes, the modified COSI questionnaire can address the client's needs and help the HCP set realistic goals for the therapy (Searchfield & Selvaratnam, 2018).

### SuddenSound Stabilizer and Oticon MyMusic

A part of everyday life is music. Music signals are highly dynamic, and many music instruments have very sharp onsets, like drumbeats or exciting the guitar string. Because of the rapid onset, these sounds can be processed as sudden sounds by the algorithm and influence the sound quality of music. However, when users change to the Oticon MyMusic program, SuddenSound Stabilizer is per default off. This preserves the sharp peaks and dynamics of music, that, to many people, makes it such an enjoyable listening experience.

You can change the MyMusic settings to accommodate each individual client. For those who find the dynamics of music difficult to listen to, you can activate SuddenSound Stabilizer to a more conservative setting.

### Expanding data logging in Oticon Genie 2

#### *The hearing journey and thriving with hearing aids*

Helping your client to stay active and engaged in conversation can easily be thought of as one of the great tasks that come to mind when we think about what we would like to do as HCPs. With the release of 23.1, Oticon Genie 2 offers an upgrade to our counselling support. With the implementation of a new Conversation Activity

function in Genie 2, the HCP can provide counselling using the hearing aid user's cumulative voice activity average in different listening environments and use this to discuss that this might mean to the user.

More data is now accessible on the daily progress of the hearing aid user, including use time, conversation activity and time spent in different environments. Conversation engagement is a factor that can be used to indicate how your clients thrive with their hearing aids. As an HCP, you can use this logging information to have a dialogue with your client about how active they are in conversation. You can discuss the impact that wearing hearing aids can have for a person's ability to converse and engage in different listening environments. With this tool, you can analyse in which types of environments your client is using their hearing aids and how much time they are engaging in conversation when they are in a particular environment. You can also use it to see how their involvement changes over time.

#### *The importance of conversation for the brain health*

Why is this an important expansion? Talking to people and having conversations is essential in social gatherings. This can be challenging for people with hearing loss. Consequently, withdrawal from social interaction can be a part of how people with hearing loss cope. Hearing loss is associated with increased feelings of loneliness and social isolation (Shukla et al., 2020). In turn, feelings of loneliness and social isolation is associated with poorer cognitive outcomes (Freak-Poli et al., 2022).

While the existence of a relationship between hearing loss and cognitive decline has been established, the potential mechanisms linking between the two hasn't reached consensus. Uchida and colleagues (2019) present several hypotheses that seek to explain this relationship. The cascade hypothesis of "use it or lose it" hints to how social interaction might come into play when explaining the relationship between hearing loss and cognition as affecting brain structure via impoverished sensory input. That is the cascading effect of hearing loss and how it affects verbal communication, can limit socialization and may lead to feelings of social isolation, loneliness and depression which in turn can lead to e.g. poorer cognitive performance and faster cognitive decline (Uchida, Sugiura, Nishita, Saji, Sone, & Ueda, 2019).

We know from literature that social health is associated with brain structure. For instance, longitudinal studies show that better perceived social support at baseline was associated with less decrease in brain volume (van der Velpen, Melis, Perry, Vernooij-Dassen, Ikram & Vernooij, 2022) and provide support to the hypothesis that social engagement preserves brain tissue (James, Glass, Caffo, Bobb, Davatzikos, Yousem & Schwartz, 2012). But besides structural associations, studies have also looked at cognitive functioning. The association between social activity and cognition has long been an area of interest in research, with systematic reviews suggesting a relationship between e.g. social activity and different aspects of cognition including overall executive functioning and global cognition (Kelly, Duff, Kelly, Power, Brennan, Lawlor & Loughrey, 2017) and social engagement and risk of dementia (Penninkilampi, Casey, Singh & Brodaty, 2018). Research find support that the social component of activity participation may be part of the contribution to cognitive well-being in later life (Litwin & Stoeckel, 2016).

As such, social engagement can provide opportunities to participate in cognitively stimulating activities. A goal of rehabilitation is to allow the client to engage more freely in social interactions. The hope with the

expansion of the data logging available in Oticon Genie 2 is that this can be utilized as a tool to motivate counselling and recommendations that enables the client to engage socially.

### *The updates to data logging in Oticon Genie 2 Environments*

You can now see an overview of time spent in different kinds of environments. The environment categorization is split into three environments: complex, moderate and simple. This split is based on the hearing aid detectors' classification. In the environments view there's a definition of these environments, e.g. a moderate environment could be a café, a busy office or an evening with friends. These definitions correspond to what you already know from the MoreSound Intelligence™ settings pane.

It is possible to see the time spent in the different environments as a percentage distribution over a time period. There's a mouseover option, where you can see change from period to period. A period is the time between fittings, and you can view both dates and total of days. In Figure 2 you see an example of data logged environments: if you hover above period 2, you can the change displayed, e.g., the percentage change in complex environments is +4% going from period 1 to 2.

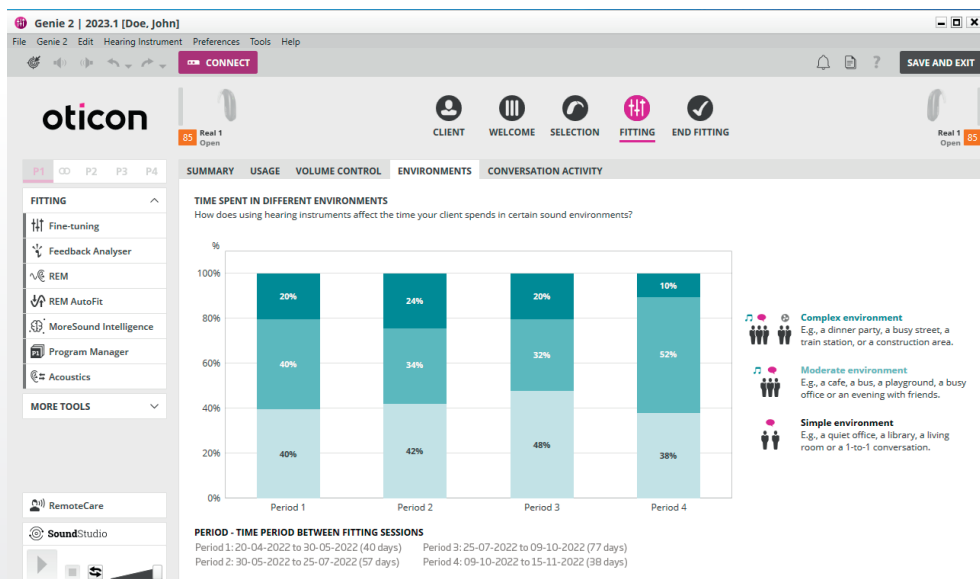


Figure 2 - Environments data logging window in Oticon Genie 2

### Conversation Activity

The new conversation activity function in Genie shows the logging of average times the hearing aid wearer is actively speaking over a time period. It is based on accumulative counts of times/moments/instances the hearing aid detectors classify the hearing aids wearers' speech as louder than surroundings. This means that what is being logged is simply an average of presence and absence of speech modulated signal, i.e. classifying a moment as having active speech. Now the HCP can see this conversation activity proportion in Genie and use this as an indication of how active a client is in conversation.

There are two panes within conversation activity; one shows conversation activity per environment and the other display conversation activity per usage period. In both displays, the right side of the graphs contains tips for the professional. This includes the important notion

that when engaging with this tool is important to note that all clients are different. This means that data can be used to compare the client with themselves and not necessarily with others. It also prompts to use the data in dialogue with your clients as a conversation starter to talk about client needs.

In the example in Figure 3, displaying conversation activity per environment, the columns represent percentage speaking time out of the entire time spent in the different environments across periods. That is, you get an overview of how much of the time the client speaks across different kinds of environments. In this particular example you can see a relatively stable percentage speaking time in both simple and complex environments. However, there is an upwards moving trend in the moderate environment, suggesting more activity in conversation in these types of environments.

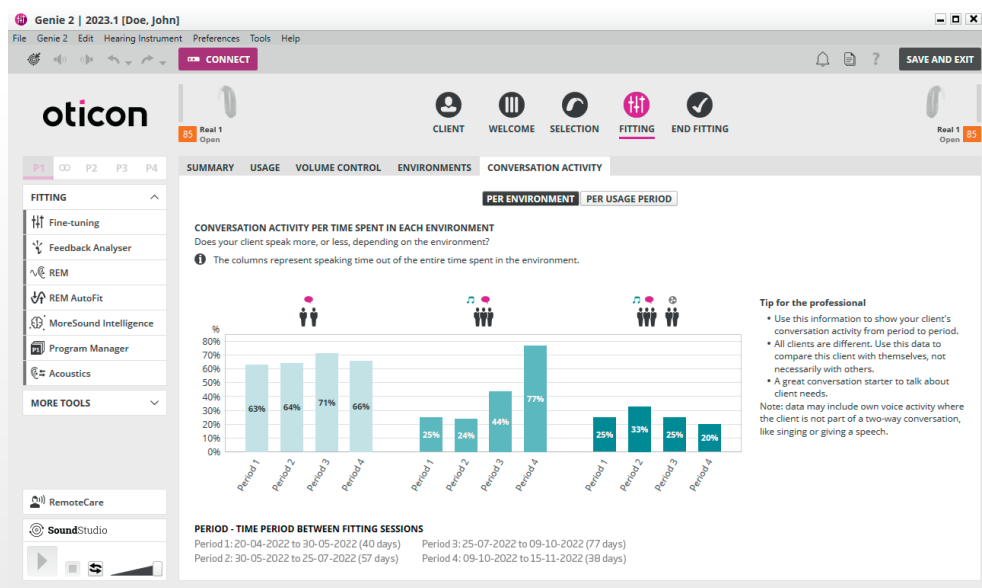


Figure 3 - Conversation Activity per environment data logging window in Oticon Genie 2

### *How to use the information for informed counselling and recommendations*

As previously mentioned, having this data available can be a great conversation starter. You can assist your client in the journey to engage more in conversation. Having the data available, you have better preconditions to have an informed dialog, ask the right questions and offer concrete advice. This can also function as part of goal setting and visualizing progress over time. Talking to the client about the activity can be done in different ways. An important part of using the information available is exploring the user's own experience and context that may be behind the data. That is, to validate the information with the client to understand the reasons behind, so you have an idea about the behaviour, choice of listening environments and how this is linked to their respective lifestyle and needs. This way the HCP can get an idea of where the patient may find the motivation to improve their hearing health. See Table 1 for examples on how to ask relevant questions.

### *A tool to guide recommendation of technology level*

Another way to use the information in counselling is providing input to giving recommendations for what technology would be suitable for a given person by taking their environment distribution into consideration. This could be done by monitoring the data logging e.g. during a trial period or using the input when changing from one hearing aid to the next. If a person is often in complex environments this can be used as a foundation for an informed talk about might be a good fitting

solution for a given patient and can be used to guide a discussion on what benefits different technology levels provide in different situations.

### *Summary*

In summary, this feature has been developed with the intention of helping the hearing aid users be able to enjoy life to the fullest. We want users to feel empowered by their hearing aids to actively participate and engage in different environments, simple as well as complex. In order to assist the users in their hearing journey, we offer a tool to the HCPs to:

- analyse in which environment the users are functioning on daily basis
- know how much time they engage in conversation while in a particular environment
- see how involvement in conversation changes over time

This way, Conversation Activity can be used as a tool for HCP who want to:

- consciously assist the users with awareness of social interaction and the importance of the stimulation to the brain by being aware of the environments and how the user functions on daily basis by offering data-informed counselling.
- a way to verify how adjustments to prescription made between different sessions influenced the user's engagement in conversation

Client mostly in simple environments	Are you happy with the hearing aids in different types of environments? How is your experience with the hearing aids when you are in more complex settings?
Client showing high speaking activity in simple environments but speaking less when environments are more complex	How is your experience participating in conversations when talking for instance 1:1? Do you feel like you are able to participate in conversations when in more noisy settings?
Monitoring conversation activity increase after increasing help in complex environments	Have you been better able to take part in conversation with your current settings in your hearing aids compared to previously? Are you happy with your current HA settings and the finetuning we did during last visit?
Taking a large share of speaking time in more complex environments, compared to the simpler environments	How are the hearing aids performing in simple environments - is it easy to follow conversations? How are they performing in more complex environments - is it easy to follow conversations and participate?

*Table 1 - Data logging, examples and relevant questions*



## References

1. Aazh, H., Moore, B. C. J., Lammaing, K., & Cropley, M. (2016). Tinnitus and hyperacusis therapy in a UK National Health Service audiology department: Patients' evaluations of the effectiveness of treatments. *International Journal of Audiology*, 55(9), 514–522. <https://doi.org/10.1080/14992027.2016.1178400>
2. Fagelson, M., & Baguley, D. (2018). Disorders of Sound Tolerance: History and Terminology. In M. Fagelson & D. Baguley (Eds.), *Hyperacusis and disorders of sound intolerance: Clinical and research perspectives*. San Diego, CA: Plural Publishing Inc.
3. Khalfa, S., Dubal, S., Veuillet, E., Perez-Diaz, F., Jouvent, R., & Collet, L. (2002). Psychometric Normalization of a Hyperacusis Questionnaire. *O.R.L. Journal for Oto-Rhino-Laryngology and Its Related Specialties*, 64(6), 436–442. <https://doi.org/10.1159/000067570>
4. James, B. D., Glass, T. A., Caffo, B., Bobb, J. F., Davatzikos, C., Yousem, D., & Schwartz, B. S. (2012). Association of social engagement with brain volumes assessed by structural MRI. *Journal of aging research*, 2012, 512714. <https://doi.org/10.1155/2012/512714>
5. Freak-Poli, R., Wagemaker, N., Wang, R., Lysen, T. S., Ikram, M. A., Vernooij, M. W., Dintica, C. S., Vernooij-Dassen, M., Melis, R. J. F., Laukka, E. J., Fratiglioni, L., Xu, W., & Tiemeier, H. (2022). Loneliness, Not Social Support, Is Associated with Cognitive Decline and Dementia Across Two Longitudinal Population-Based Cohorts. *Journal of Alzheimer's disease : JAD*, 85(1), 295–308. <https://doi.org/10.3233/JAD-210330>
6. Kelly, M. E., Duff, H., Kelly, S., McHugh Power, J. E., Brennan, S., Lawlor, B. A., & Loughrey, D. G. (2017). The impact of social activities, social networks, social support and social relationships on the cognitive functioning of healthy older adults: a systematic review. *Systematic reviews*, 6(1), 259. <https://doi.org/10.1186/s13643-017-0632-2>
7. Litwin, H., & Stoeckel, K. J. (2016). Social Network, Activity Participation, and Cognition: A Complex Relationship. *Research on aging*, 38(1), 76–97. <https://doi.org/10.1177/0164027515581422>
8. Penninkilampi, R., Casey, A. N., Singh, M. F., & Brodaty, H. (2018). The Association between Social Engagement, Loneliness, and Risk of Dementia: A Systematic Review and Meta-Analysis. *Journal of Alzheimer's disease : JAD*, 66(4), 1619–1633. <https://doi.org/10.3233/JAD-180439>
9. Santurette, S., Brændgaard, M., Wang, J., & Sun, K. (2023). SuddenSound Stabilizer - Evidence and user benefits. Oticon Whitepaper.
10. Searchfield, G., & Selvaratnam, C. (2018). Hearing Aids for Decreased Sound Tolerance and Minimal Hearing Loss: Gain Without Pain. In M. Fagelson & D. Baguley (Eds.), *Hyperacusis and disorders of sound intolerance: Clinical and research perspectives*. San Diego, CA: Plural Publishing Inc.
11. Shukla, A., Harper, M., Pedersen, E., Goman, A., Suen, J. J., Price, C., Applebaum, J., Hoyer, M., Lin, F. R., & Reed, N. S. (2020). Hearing Loss, Loneliness, and Social Isolation: A Systematic Review. *Otolaryngology--head and neck surgery : official journal of American Academy of Otolaryngology-Head and Neck Surgery*, 162(5), 622–633. <https://doi.org/10.1177/0194599820910377>
12. Uchida, Y., Sugiura, S., Nishita, Y., Saji, N., Sone, M., & Ueda, H. (2019). Age-related hearing loss and cognitive decline - The potential mechanisms linking the two. *Auris, nasus, larynx*, 46(1), 1–9. <https://doi.org/10.1016/j.anl.2018.08.010>
13. van der Velpen, I. F., Melis, R., Perry, M., Vernooij-Dassen, M., Ikram, M. A., & Vernooij, M. W. (2022). Social Health Is Associated With Structural Brain Changes in Older Adults: The Rotterdam Study. *Biological psychiatry. Cognitive neuroscience and neuroimaging*, 7(7), 659–668. <https://doi.org/10.1016/j.bpsc.2021.01.009>

