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Fitting Opn for persons with tinnitus

INTRODUCTION

People with hearing loss and tinnitus need extra support in many every day listening environments. In quiet or simple listening environments, the tinnitus can dominate because it is challenging not to focus on it when no other sounds are available to help divert attention to more pleasant sounds. The integrated sound generator in Opn, Tinnitus SoundSupport™ can help tinnitus patients through targeted sound therapy. In complex or noisy listening environments with multiple speakers and sound sources, tinnitus adds to the cognitive load on the brain, much like hearing loss does. Being more tired, more stressed or more anxious can also exacerbate tinnitus perception. Oticon Opn hearing aids provide signal processing that supports patients with tinnitus in multiple environments by decreasing the load on the brain and helping to focus on positive and meaningful sounds. Recommendations for Opn hearing aid settings are provided in terms of features and adjustments, supporting individualized patient treatment plans.

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Hearing aids for sound therapy

In essence, sound therapy is defined as any use of sound that is intended to alter tinnitus perception and/or reactions to tinnitus for clinical benefit (Tunkel et al, 2014). Sound therapy as a systematic approach started with Jack Vernon's tinnitus masking approach in the 1970s (Vernon, 1978, McFadden, 1982). Sound therapy is thought to provide relief from tinnitus and reduce the emotional consequences of tinnitus (Tunkel et al, 2014). The evidence to support the use of sound therapy is somewhat limited due to the low number of high quality randomized controlled trials that single-handedly test the merits of hearing aids or combination devices (hearing aids with a built-in sound generator). The reason often lies in the fact that hearing aids are rarely tested in isolation, but rather as part of a broader treatment approach that includes counselling, the amount and content of which varies from study to study. In fact, it is always recommended to provide hearing aid sound therapy accompanied by thorough counselling of the patient. It is also always recommended to refer patients to other health care professionals if their symptoms suggest psychologic or medical intervention (Tunkel et al, 2014). The Cochrane review of sound therapy for tinnitus treatment concludes that although the data to support sound therapy by itself is limited, this does not necessarily mean a lack of clinical efficacy in the management of tinnitus (Hobson et al, 2012).

Providing **audibility** for target speech and environmental sounds is key to providing sound therapy using hearing aids. First and foremost, the task of the hearing aid is to make sure that sound is accessible. The second and more complex task is an emerging area of study having to do with the **cognitive benefits** associated with hearing better. It is widely accepted by tinnitus experts that tinnitus is associated with reduced cognitive function in terms of ability to concentrate and effect on memory (see next sections). However, it is still not clear what effect tinnitus has and how other factors play a role (Rossiter et al, 2006). The two next sections will address audibility and cognitive effects as they relate to different everyday listening environments.

Quiet and simple listening environments

The people who wear hearing aids or combination devices for tinnitus are assumed to have some degree of hearing loss ranging from mild to severe. A common complaint in quiet environments is that the internal tinnitus sound can be heard quite clearly. Presumably, this is because the contrast between the internal tinnitus sound (louder) and the external environmental sounds (softer) is large and this allows the brain to focus on the available sound – the tinnitus. The audibility of external sounds is therefore crucial in order to reduce this contrast between the tinnitus sound and the environment.

The distraction of tinnitus affects the person's ability to concentrate when they are having a conversation with one or two other persons. Poor concentration in turn affects the person's ability to remember parts of the conversation at a later time (Andersson, 2009). The most plausible reasons that persons with tinnitus have difficulty concentrating are the hearing loss, but could also be linked to the emotional distress associated with tinnitus (Mohamad et al, 2016, Andersson, 2009). Overall, 80-90% of people with tinnitus also have some degree of hearing loss (Beck, 2012, Davis & Refaie, 2000). This means that the cognitive effects of having a hearing loss (ability to concentrate, listening effort, and memory/recall ability) have to be considered when working with the vast majority of persons with tinnitus. Choosing amplification such as Oticon Opn that has proven positive effects on listening effort and recall ability (Le Goff et al, 2016), even in easier listening environments (with positive signal-to-noise ratios of 5-7 dB), is therefore recommended.

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In simple listening environments, hearing aids must restore audibility in frequency regions associated with auditory deprivation. Increasing sound stimulation may restore neural function due to neuroplastic changes in the brain (Del Bo & Ambrosetti, 2007). In these environments, tinnitus patients and most people with hearing loss typically prefer little to no noise reduction. This stems from a desire to be able to hear sounds around you and interact appropriately and in a timely manner with the environment, but also from the fact that more environmental sound positively affects tinnitus perception (Heller & Bergman, 1953). For hearing aid technology, this often translates into a traditional omni-directional hearing aid microphone setting where sounds are amplified regardless of their direction. In Opn, this corresponds well with the noise reduction and directionality settings for simple environments and preserving speech and non-intrusive environmental sound.

Complex and noisy listening environments

There are three issues that tinnitus patients will often mention when talking about noisy listening environments: difficulty concentrating, fear of noise exposure, and decreased sound tolerance.

Concentration difficulties

Being tired, stressed and anxious can exacerbate tinnitus perception (Durai & Searchfield, 2016, Welch & Dawes, 2008, Bartels et al, 2010, Scott & Lindberg, 2000). A common complaint for tinnitus patients in complex and noisy listening environments is that they have difficulty concentrating and focusing attention on what they want to hear (Andersson, 2009). Andersson (2009) also writes, based on his extensive clinical experience, "While the role of hearing loss in understanding conversation is fairly obvious, many patients find that it is tinnitus more than hearing loss that makes communication more difficult". This may be because tinnitus increases the demand on auditory processing (Mohamad et al, 2016).

> Many patients find that it is **tinnitus** more than **hearing loss** that makes communication more difficult

Our brains have a finite cognitive capacity for hearing and understanding speech (Rudner et al, 2007) and having tinnitus creates an additional load on the brain in these difficult environments where the brain is already overloaded. Having tinnitus uses more cognitive resources because tinnitus is its own distinct auditory object and our brains are therefore specifically wired to pay attention to it (Cuny et al, 2004, Searchfield, 2012). Actively focusing on other sounds costs extra cognitive resources (Searchfield et al, 2012). To further add to the difficulty, there are indications that persons with hearing loss and tinnitus do not perform as well on speech-in-noise tasks as their hearing loss only counterparts, although research is limited in this area (Newman et al, 1994).

Recent studies show that the Opn hearing aid improves speech understanding in noise, leading to less listening effort in these situations (Wendt, in Le Goff et al, 2016, Wendt et al, 2016, Ohlenforst et al, 2016). This, in turn, leads to improved information recall later on (Lunner et al, 2016, Ng et al, 2015). It means that Opn technology helps decrease the load on the brain and this frees up more cognitive capacity for other tasks. For persons with tinnitus, this allows them to focus attention more actively away from the tinnitus. In essence, for the brain challenged by both hearing loss and tinnitus, wearing Opn frees up resources to focus more easily on positive and meaningful sounds, rather than the tinnitus.

Fear of noise exposure

People with tinnitus know that exposure to hazardous noise is one of the most common causes of hearing loss and tinnitus. They are therefore reluctant to spend time in complex environments for fear of exacerbating their tinnitus. OpenSound Navigator shields them from loud and uncomfortable sound while maintaining access to important speech cues from all directions . This will benefit this population and make them feel confident that they are not damaging their ears further.

Decreased sound tolerance

Approximately 40-55% of people with tinnitus also suffer from decreased sound tolerance, known as hyperacusis (Schecklmann et al, 2014). This means that many patients avoid or are wary of any listening environments associated with noise, even if the level of noise is safe, because they perceive the level of noise to be louder and more uncomfortable than everyone else. Prior to the development of Multiple Speaker Access Technology (MSAT) which is implemented in the OpenSound Navigator™ feature in Opn, the only option for shielding hearing aid wearers from unwanted noise in these environments was the use of narrow directionality and aggressive noise reduction. Given the disadvantages associated with narrow directionality (Brimijoin et al, 2014, Picou & Ricketts, 2015), another alternative is needed for persons with hearing loss, tinnitus and hyperacusis.

> Wearing Opn **frees up resources** to focus more easily on positive and meaningful sounds, rather than the tinnitus

As part of sound therapy, Opn hearing aids help people with hearing loss and tinnitus by delivering high quality sound to the brain. The OpenSound Navigator feature reduces localized and diffuse noise in the environment and the result is the preservation of a rich sound environment while simultaneously removing the discomfort of loud and uncomfortable sounds. This makes it possible to use amplified sound more effectively as part of a sound therapy treatment approach.

Recommendations for fitting Opn for tinnitus

Based on Grant Searchfield's 2016 recommendations for fitting hearing aids on people with tinnitus, as well as the evidence published on Oticon Opn technology, a list of considerations has been compiled for the clinician working with the tinnitus population for recommendations on hearing aid bandwidth and hearing aids styles, please refer to the Oticon white paper on tinnitus fittings (Callaway, 2014). Furthermore, the evidence behind tinnitus relief sounds and the arguments behind having a diverse variety to choose from are presented in this 2014 white paper.

Binaural fitting

Fitting both ears with hearing aids is recommended for tinnitus patients with hearing loss, even if they only have tinnitus in one ear (Jastreboff, conversation, AAA 2015, Del Bo & Ambrosetti, 2007, Searchfield, 2016). One argument is that this allows symmetrical stimulation of the auditory system and mimimizes the risk that the tinnitus will simply cross over to the non-symptomatic ear, although there are currently no studies to verify this. It is, however, a reported finding amongst clinicians with sound therapy experience.

Open fitting

If a person with tinnitus has good low frequency hearing, it is preferable to keep the ear open to allow direct access to helpful environmental sounds that can work as sound therapy quite naturally (Del Bo & Ambrosetti, 2007, Searchfield, 2016, Parazzini et al, 2011). An open fitting is here defined as the use of the most open dome appropriate . It also applies to molds with large vents. Open fittings minimize the occlusion effect and a closed sensation of the ear can sometimes worsen tinnitus perception (Henry, 2008, NCRAR website, 2015). This does not apply to persons with low frequency hearing loss who need amplification of low level environmental sounds to benefit from sound therapy. In these cases, it may be preferable to have a closed fitting that gives more access to these sounds.

Hearing aids or combination devices?

Searchfield (2016) argues that hearing aids alone may be sufficient for patients with normal or near-normal hearing in the low frequencies. This is due to the fact that access to environmental sound and amplification in the high frequencies alone can be enough to make the systematic use of sound in sound therapy beneficial. For persons with more hearing loss in low frequencies, it may not be possible to amplify environmental sounds sufficiently with the hearing aids alone. These may be cases where a sound generator in a combination device can prove beneficial, since static or modulated relief sounds are sent directly into the ear from the hearing aid speaker. In Opn, the sound generator is called **Tinnitus SoundSupport™** and it provides the patient with a variety of pleasant relief sounds. In a fitting, the patient should have a chance to listen to all relief sounds so they can choose the ones that appeal the most to them. For a guide on how to present Oticon's relief sound in a quick and systematic way, we refer to Oticon's Tinnitus Quick Fitting Guide, and for more detail, the Tinnitus Management Handbook for Clinicians (available from Oticon).

Fitting rationales

An important consideration here is that the amplification best suited to compensate for hearing loss is not necessarily the amplification best suited for tinnitus treatment and vice versa (Shekhawat et al, 2013). As an example, tinnitus perception may decrease with more access to environmental sound, while the person with hearing loss may prefer more noise reduction in some situations. Shekhawat et al (2013) concluded that the Desired Sensation Level DSL V.5 might be a good starting point since DSL V.5 gives higher gain to soft sounds than some other rationales. For the fitting of Opn, the proprietary **Voice Aligned Compression (VAC+) rationale** is recommended since it will optimize the use of signal processing algorithms within the device.

> Amplification best suited to **compensate for hearing loss** is not necessarily the amplification best suited for tinnitus treatment

Compression and compression kneepoint

Searchfield (2016) recommends low compression kneepoints to ensure audibility of ambient sounds. Compared to conventional amplification strategies, VAC+ provides less gain at high input levels, and more gain at low input levels by means of a lower compression kneepoint. The low-level knee points at high frequencies can be adjusted higher or lower, depending on patient preference, using the **Soft Sound Perception** control in Genie 2. **Soft Speech Booster LX** provides access to soft sounds in quiet environments.

The **SpeechGuard LX** feature also fits well into this recommendation, since it allows us to provide the patient with more compression with fewer side effects due to the 12 dB dynamic range linear window for the

amplification of speech. Pittman et al (2014) demonstrated that people with hearing aids had improved attentional abilities when SpeechGuard was used, compared to more traditional compression approaches. Since people with tinnitus problems may experience more concentration difficulties, improved attentional abilities may prove an advantage.

Expansion

The purpose of expansion, also known as soft squelch, is to lower the internal noise of the hearing aid, mainly microphone noise. Searchfield (2016) recommends turning expansion off for persons with tinnitus, since the internal hearing aid noise constitutes a soft ambient sound that could potentially act as a masker for the person with normal or near-normal hearing in the low frequencies. In Opn, this features is called **Silencer**. For input levels below 30 dB SPL, Silencer reduces gain more rapidly so they are not amplified. Silencer can be turned off in the fitting software preferences. We should recognize that not every patient will accept the addition of microphone noise to the sound signal, especially if they have good low frequency hearing. However, Silencer should be considered an additional tool available for the clinician working with tinnitus. Counselling the patient on the deliberate use of this sound in therapy may help them to embrace it as part of their tinnitus treatment.

Directionality and noise reduction

The **OpenSound Navigator**™ feature in Opn handles both aspects of directionality and noise reduction Please refer to the OpenSound Navigator white paper for detailed information on functionality (Le Goff et al, 2016). This feature is the most important reason to choose Opn over other hearing aids for tinnitus management as outlined in the earlier sections about simple and complex listening environments. Here, we go into a bit more detail.

Quiet and simple listening environments. If we are to follow the traditional recommendation of using omni-directional microphones for tinnitus patients in this environment, then the Pinna Omni directionality setting is helpful. In this setting, however, OpenSound Navigator is deactivated. Instead, the recommendation is to select Open Automatic as shown in figure 1. Depending on what profile you choose (low, medium, high), you will have little or no noise reduction in simple environments and directionality will be Pinna Omni. This gives good access to meaningful environmental sound in quiet environments while reducing potentially annoying static noises that may be present. Talk to the patient to explore what they would like to hear in different environments and choose a profile accordingly. The goal in sound therapy isn't necessarily to add broadband relief sounds to the existing environment, but overall, the goal is to give the patient meaningful and positive sound to focus on. OpenSound Navigator aims to do this in its signal processing scheme.

Noisy and complex listening environments. In complex environments, the recommendation from leading tinnitus experts (Searchfield, in Baguley & Fagelson, 2016) is to essentially turn noise reduction off when the goal of the fitting is to address tinnitus, and to use an omni-directional microphone setting. There is a definite recognition of the competing needs of communicating well and addressing tinnitus interference in conversation (Searchfield, 2016) and this is the difficult tradeoff that clinicians have been faced with.

Instead of subjecting the patient to a lot of potentially annoying and disruptive sound in this difficult environ-

Figure 1. Youmatic settings for simple and complex listening environments in Genie 2

ment, the recommendation using Opn is to allow noise reduction to stay activated and to select Open Automatic in the OpenSound Navigator feature. This allows the OpenSound Navigator to be fully activated. It analyses all incoming sound to determine what is speech and what is more like noise. Opn then reduces noise in two ways, reducing both dominant localised noise sources and the overall noise level. The effect of this is to preserve a rich sound environment while removing the discomfort of loud and uncomfortable sounds. This provides our tinnitus patients with a cleaner, richer and less taxing sound, which allows them to not tire as easily in these situations. OpenSound Navigator essentially provides access to sounds around the patient, while providing targeted noise reduction for loud and unwanted noise, rather than isolating a target speaker using a narrow directionality paradigm. We believe this is the right balance to strike for the difficult dilemma clinicians are faced with: providing more sound for tinnitus and less noise for comfort and better speech understanding.

Youmatic LX helps the clinician customize the amount of noise reduction given to the tinnitus patient, since some can tolerate more background noise and others prefer less. This preference is very individual and the OpenSound Navigator must be set accordingly. In Youmatic LX, the amount of noise reduction is fully adaptable in regards to how much help the patient needs and in which environments they need it. Thus, we argue that Opn combines the goals of improving audibility while maintaining access to environmental sounds in multiple listening environments, for tinnitus patients with varying needs.

Wireless communication and apps

Easy access to additional tinnitus relief sounds can be especially helpful to a patient with tinnitus. There are apps available specifically for tinnitus or relaxation needs. It may also be in the form of preferred music and podcasts that help distract the patient from their tinnitus. Using 2.4 GHz technology, Opn hearing aids connect directly to compatible wireless devices and mobile phones.

Counselling recommendations

For more detailed information on tinnitus counselling, we refer to the Oticon Tinnitus Management Handbook for Clinicians and well as the Patient Education and Counselling Tool. However, an important consideration should be mentioned here in regards to freeing up cognitive capacity using Opn hearing aids. The hearing care professional must ensure that they include the use of positive and meaningful sound as part of the counselling session (Searchfield, conversation, 2016).

When the cognitive capacity of the tinnitus brain has been reduced, then it is vital for the patient to understand that they should use this extra capacity to focus on positive and meaningful sounds in the environment, rather than diverting more attention to tinnitus. Positive and meaningful sounds may include conversations with others, music listening or focusing on a good plot in a film.

> Clinicians must ensure that they include the use of **positive and meaningful sound** as part of their counselling

Concluding remarks

With Opn, Oticon has developed a product that supports patients with tinnitus and hearing loss in both simple and complex listening environments. The paradox lies in providing patients with audibility and access to sound, yet ensuring that they are not bothered by the addition of too much sound. Narrow directionality paradigms isolate target speech but cut off potentially useful environmental sounds for sound therapy. When using Opn for tinnitus, the hearing care professional can stray from the at times problematic recommendation of using omni-directional/no-noise-reduction settings for tinnitus patients. This is possible due to the advanced signal processing algorithm in OpenSound Navigator, which allows access to ambient and useful environmental sounds while ensuring a reduction of loud and uncomfortable noise.

Every person with tinnitus is different and has varying needs in terms of what kind of sound they prefer and how much they want to hear. With Opn, the hearing care professional can individualise tinnitus relief sounds in a multitude of ways and they can consider the hearing aid signal processing itself an important part of their tinnitus toolbox.

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