

Telemedical Approach to Tinnitus Treatment: Customized Harmonic Sound and Music Therapy

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Figure 1. AirDrives Interactive Stereo earphones: the speaker sits outside of the ear and transmits sound via the tragal cartilage and prevents the participant from being acoustically isolated.

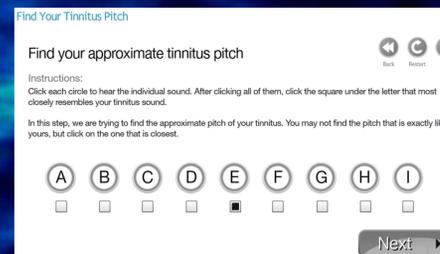


Figure 2. Tinnitus frequency matching with web-based multiple-choice protocol (250 Hz to 12000 Hz in 5 octave steps).



Figure 3. Tinnitus frequency matching with web-based slider protocol (20 to 20000 Hz).

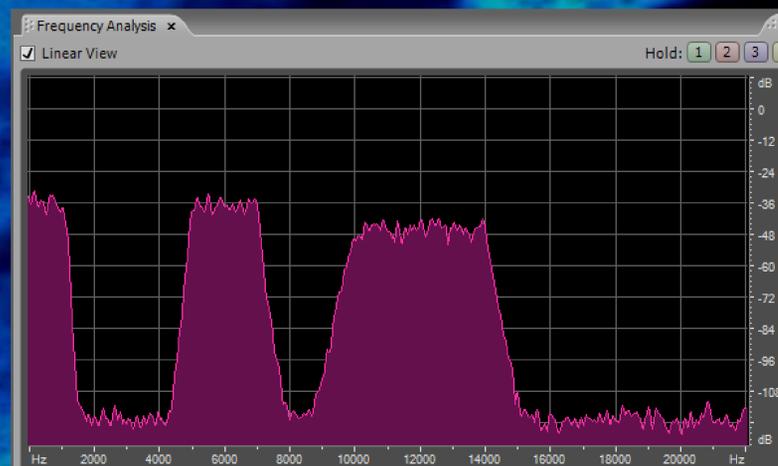


Figure 4. Harmonic Sound Therapy file is composed of series of narrow-band noise peaks centered on the tinnitus frequency and the first and fifth sub-harmonics. The width of these bands is one-half octave of the center frequency. A sample is shown below where the patient matched the frequency at 12 kHz.

ABSTRACT

Harmonic Sound and Music Therapy is a patent-pending sound therapy protocol. Patients are able to access the site, find their tinnitus pitch and download the customized sound therapy file and/or mix it with their own music files. Twenty-eight patients with constant tinnitus were enrolled in the study. First, subjects listen to the customized Harmonic Sound Therapy file for 2 weeks for a minimum of 2h/day. Then, they listened to a mixture of Harmonic Sound Therapy with music for a minimum of 2h/day for the next 5.5 months. Outcomes were assessed using a VAS for loudness and annoyance as well as the Tinnitus Handicap Inventory (THI). Overall, 24 of the 28 patients (89%) showed a significant improvement in loudness, annoyance, and THI. The mean score of tinnitus loudness changed from 6.0 to 3.3. THI score was reduced in 75% of patients by at least 30%. In the entire cohort, the mean difference in THI was 20 (range -2 to 52). Customized harmonic sound and music therapy is an effective method of tinnitus treatment. The software will allow this treatment to be delivered in a telemedical approach via the web to anywhere in the world. This treatment is suited for forward field applications as well as for veterans located in remote parts of the U.S. or world.

INTRODUCTION

Of several introduced treatments, sound therapies are the most widely used option¹. Traditional (non-customized) masking efforts have presented broadband noises. A disadvantage with broadband noise is that it masks the subject's hearing at all frequencies, sets limits on the duration of listening, on the rate and degree of tinnitus rehabilitation, and deteriorates the intelligibility of the speech^{2,3}. It is acknowledged that targeted (customized) acoustic energy provides more effective masking than broad-based acoustic energy³⁻⁶. Unfortunately, with this approximation, the therapeutic sound might also become more noxious. There are a number of drawbacks with most of the introduced sound therapy treatments as they require multiple visits to care provider, special equipments or they are simply too expensive. To address these issues, we have developed Harmonic Sound and Music Therapy as a method of tinnitus treatment. Harmonic Sound Therapy is a customized masking strategy specifically designed to deliver non-noxious targeted acoustic energy, yet at the same time allow significant portions of the hearing spectrum to remain unmasked.

METHODS

•Subjects:

- Thirty-two patients 18 years or older with tinnitus (minimum duration of 6 months), were enrolled in the study. Each participant was provided with a unique username and password, a MP3 player and AirDrives Interactive Stereo Earphones (Figure 1).

• Web-based Protocols (available at www.beyondtinnitus.com):

- **Tinnitus Assessment:** Participants were asked about the dominant ear, loudness and tinnitus type (tonal/ ringing vs. hissing/ buzzing). Then, they had to match the frequency of their tinnitus using the web-based software with a multiple-choice protocol (Figure 2) and a slider (Figure 3). Octave challenge testing was performed if they used the multiple choice.
- **Harmonic Sound Therapy:** The website would then implement participants' selections of frequency, loudness and inter-aural characteristics to construct a customized Harmonic Sound Therapy file (Figure 4). Subjects were instructed to listen to the sound therapy file on the MP3 player for 2 weeks for a minimum of 2 hours per day using the earphones.
- **Harmonic Music Therapy:** The second stage involves listening to a mixture of the harmonic sound therapy with music for a minimum of 2 hours a day for the next 5.5 months.

• Outcome Measurements:

- Visual analog scale(VAS) for loudness and annoyance as well as the Tinnitus Handicap Inventory (THI) were recorded before and after successful completion of the treatment period.

RESULTS

- Twenty-eight participants successfully completed the treatment. The sample population consisted of 10 females and 18 males. Mean age of participants was 49 years old (SD ± 9.4; range 32 to 67). Participants' tinnitus pitch had an average of 6438 (SD ± 3004; range 2000-12000). Tinnitus in 59% was tonal/ringing. In 53%, tinnitus was present in both ears, in 28% in right ear and in 19% in left ear.

- Tinnitus loudness and annoyance results are shown in Table 1.

Table1. Tinnitus loudness and annoyance on visual analog scale, before and after Harmonic Sound and

Music Therapy with web-based protocol (n=28).

	Before		After		P value	Reduction ≥ 25%	Reduction ≥ 50%	Reduction ≥ 100%
	(mean ± SD)	Range	(mean ± SD)	Range				
Tinnitus Loudness	6.0 ± 2.3	2 - 10	3.3 ± 1.9	0 - 6	<0.001	72%	34%	13%
Tinnitus Annoyance	6.1 ± 2.6	1 - 10	3.1 ± 2.0	0 - 8	<0.001	72%	56%	9%

* SD: standard deviation

- Overall, 24 of the 28 patients (89%) showed a significant improvement in loudness, annoyance, and THI. THI score was reduced in 75% of patients by at least 30%. In the entire cohort, the mean difference in THI was 20 (range -2 to 52).

DISCUSSION

Customized harmonic sound and music therapy is an effective method of tinnitus treatment in patients with tinnitus. The software that has been developed will allow this treatment to be delivered in a telemedical approach via the web to anywhere in the world. This treatment is suited for forward field applications as well as for veterans located in remote parts of the U.S. or world. An audiologist based in a medical center can help a service member in the field or in a remote location with delivery of customized sound therapy over the web. The service member or veteran can also use their own music to develop customized music therapy files using the web-based protocol. The use of open-ear headphones allows for the user to hear outside sounds while listening to therapy sounds.

CONCLUSION

- A web-based tinnitus matching protocol is as effective as a standard protocol using an audiometer in identifying the patient's tinnitus frequency.
- Web-based delivery of customized sound and music therapy for tinnitus is a practical and potential solution for the treatment of tinnitus.

- This study has shown that Harmonic Sound and Music Therapy is effective in reduction of tinnitus in a large number of subjects.

- This study will illuminate the path towards future studies and applications of internet-delivered customized Harmonic Sound Therapy in larger populations and controlled trials.

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