Hypermonitoring – Measuring the Perceptual Mismatch in Tinnitus
in Programmed Serenade Devices

Jeff Carroll, PhD
Director of Clinical Services and Engineering, SoundCure, Inc.

ABSTRACT

Tinnitus can be a debilitating condition but little is known why some suffer from tinnitus while others merely are aware of the tinnitus with little impact on their lives. Studies have shown that audiologic factors such as amount of hearing loss or tinnitus characteristics do not offer an explanation. One possible explanation is that patients may perceive their tinnitus differently. There is a great deal of evidence in the psychological literature to suggest that perception and objective reality often are discrepant. This data review, based on programmed Serenade devices, aimed to use a semi-objective method developed at SoundCure and integrated into the Serenade software to assess this perceptual difference that we'll refer to as hypermonitoring. Patients rated the loudness of their tinnitus as well as the loudness of a tone that was determined to be equivalent to their tinnitus in pitch and loudness. A ranking of their tinnitus as louder than the equivalent sound is an indication of hypermonitoring. This data may prove to be a valuable tool in determining treatment suitability, counseling patients on the process of habituation or potentially the mechanism of treatment, but long term controlled studies are needed. The next steps are to collect a control set of patients who experience tinnitus but are not bothered by it or seek treatment for it.

CONTACT

Jeff Carroll, PhD
SoundCure, Inc
Email: jeff.carroll@soundcure.com
Website: www.soundcure.com

INTRODUCTION

Tinnitus is often described as having a small sensation level or dBSL, and is therefore a soft sound. In fact, according to an extensive data set of 1422 patients measured as part of the OHSU tinnitus archive, over 84% of patients match their tinnitus to less than 10 dBSL and over 40% match to less than 3 dBSL [1]. Unfortunately, hearing loss, recruitment and hyperacusis all can compromise a normal loudness growth function such that dBSL is not a meaningful unit in terms of understanding loudness of tinnitus. Further, many patients self report the loudness of their tinnitus that seems to be inconsistent with the matched loudness of their tinnitus, using units of dBSL, assuming a normal degree of loudness growth.

This data review, based on programmed Serenade devices, aims to use a patient's self assessment of their tinnitus loudness match as a comparison to their self assessed tinnitus loudness. Patients reporting their tinnitus as louder than the ranking of their tinnitus match can be said to be hypermonitoring. Hypermonitoring will be used to describe a subconscious process of the erroneous perception of tinnitus as loud when it should otherwise be soft, and not an attentional problem.

METHODS AND MATERIALS

119 patients were evaluated using the SoundCure Serenade Tinnitus Treatment System. 3 patients were evaluated twice for a total of 122 data points. Patients were actual patients who had a programmed Serenade device from a SoundCure provider. The dataset was collected from 81 providers. Data were analyzed from the SoundCure programming database on which the Serenade software runs.

The Serenade software includes an optional test in which a provider can collect the ranked loudness of a patient's tinnitus as a counseling tool. The procedure is as follows:
1. A tinnitus pitch match is found using a loudness balanced slider.
2. A tinnitus loudness match is found at the pitch match using an adaptive procedure.
3. The patient's subjective loudness is assessed using a 1-10 scale. The patient is asked about loudness and not severity.
4. The patient is asked to rank the loudness of their pitch match at 4 loudness levels presented 2 times each and averaged across the 2 presentations. The four loudness are: Threshold, Tinnitus Match, 25% above match, and 50% above match.(% above match represents relative amount toward ULL)

The ranking of the Tinnitus Match can now be compared to the Subjective Match.

RESULTS

The average Subjective Tinnitus level is 5.8 +/-2.3. The average Ranking of the Matched Loudness is 1.9 +/- 1.7. This indicates that on average patients are hypermonitoring by 3.9 +/- 2.6 points.

Figure 1 shows a scatter plot of the Subjective Loudness vs. the Ranking of the Matched Loudness. The solid diagonal represents values that would exist if a patient ranks their tinnitus the same as they rank the sound they match to their tinnitus. Dashed lines represent a subject error tolerance of +/- 1 point. Values above the diagonal represent hypermonitoring.
- 104 of 122 (85%) are Hypermonitoring
- 14 of 122 (11%) perceive their tinnitus accurately
- 4 of 122 (3%) fall below the line. It is unclear what may cause this phenomenon

Figure 2 shows the Subjective and Matched loudness data for each patient. A paired samples 2-tailed t-test was performed on the data. The Matched Loudness Data are statistically lower than the Subjective Rankings (p<0.000001).

Figure 3 shows the distribution of patients across the loudness scale for each the Subjective Rankings and the Match Loudness Rankings. It can be seen there is a much greater distribution of the Subjective Rankings.
- 100 of the 122 (82%) Matched Rankings are 3 or less indicating a majority of tinnitus patients do have soft tinnitus.

Figure 1. Magnitude of Hypermonitoring

Figure 2. Trends in Hypermonitoring

Figure 3. Patient Distribution of Perceived vs. Matched Loudness

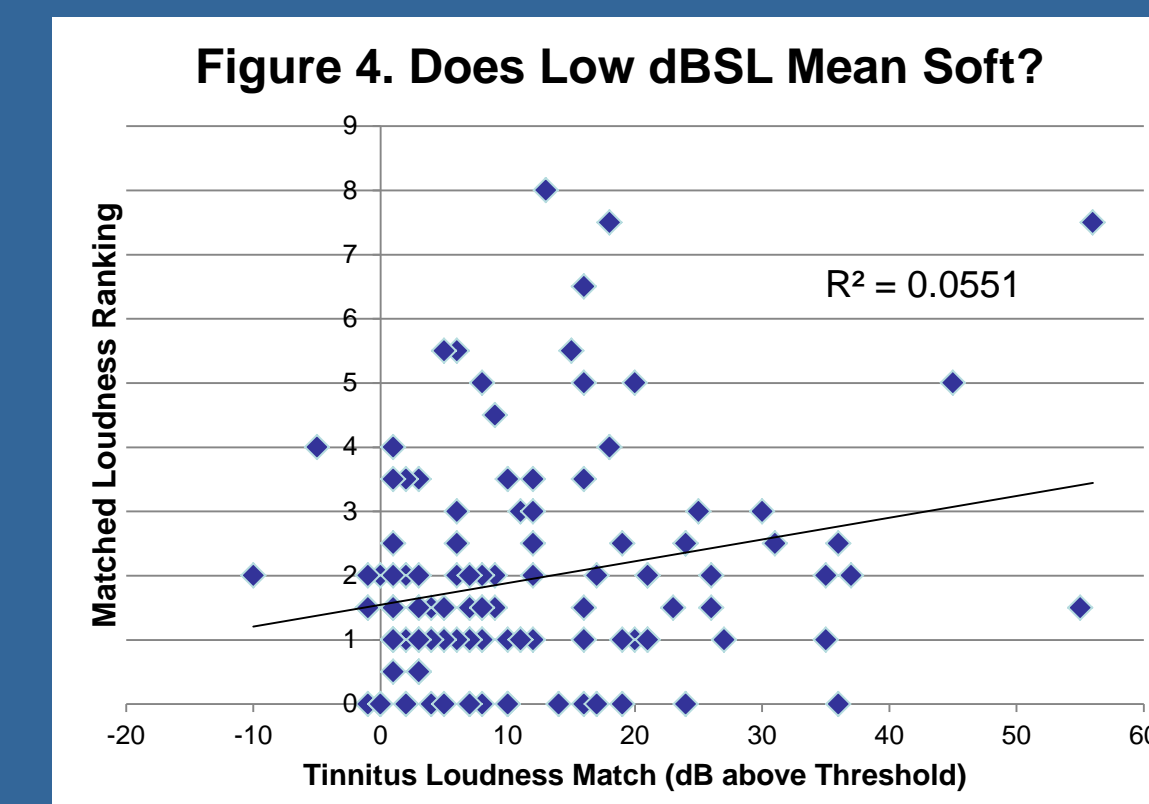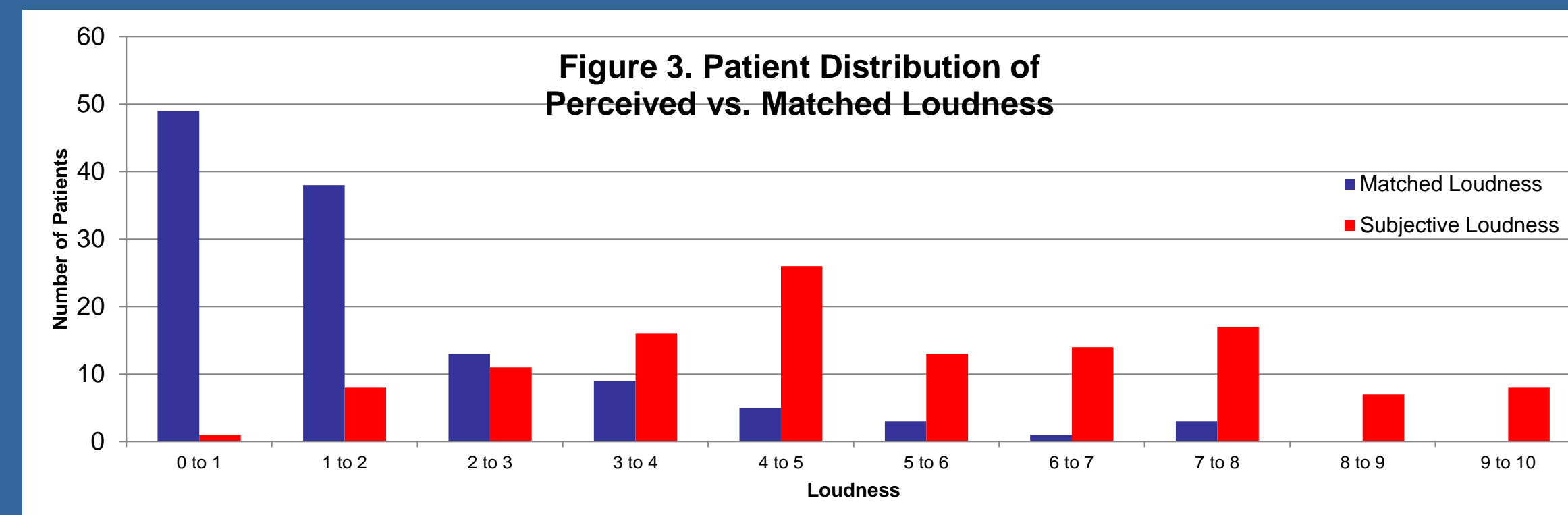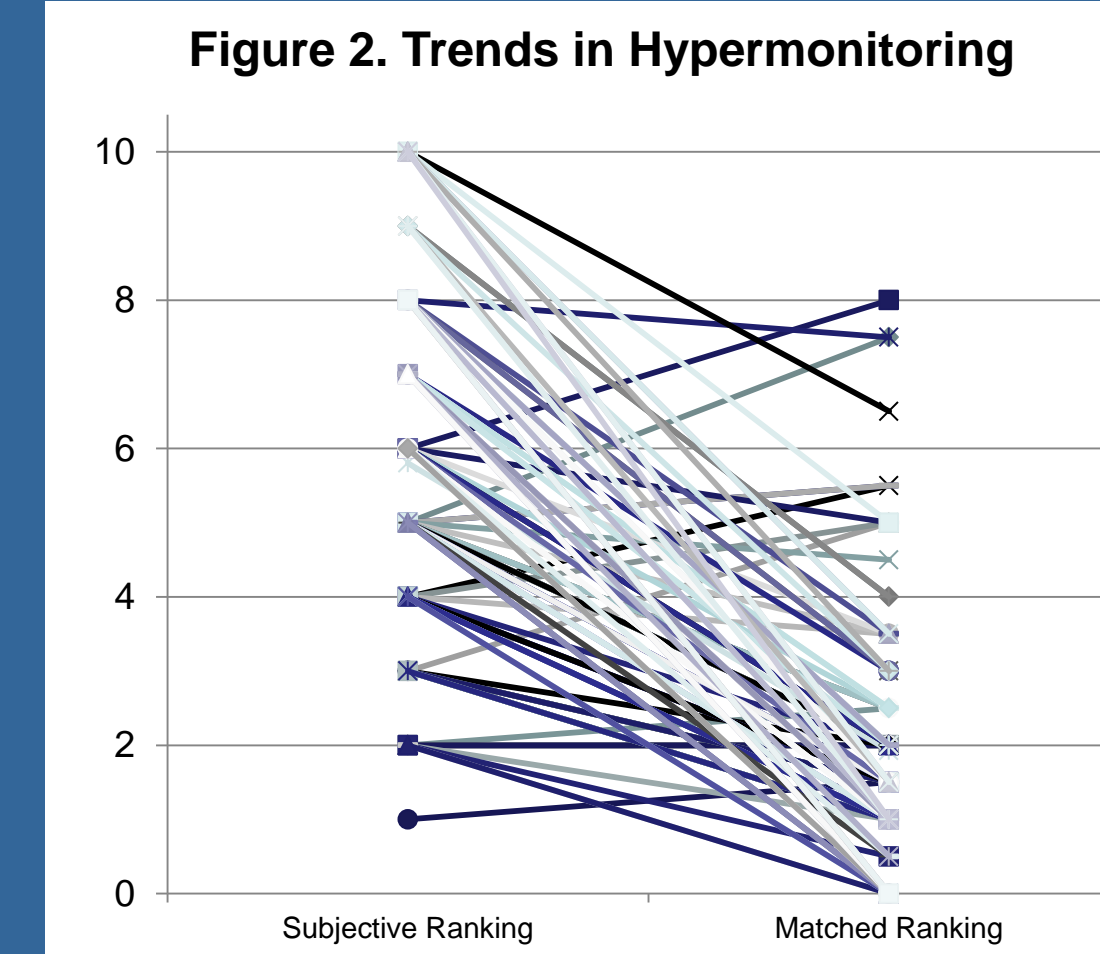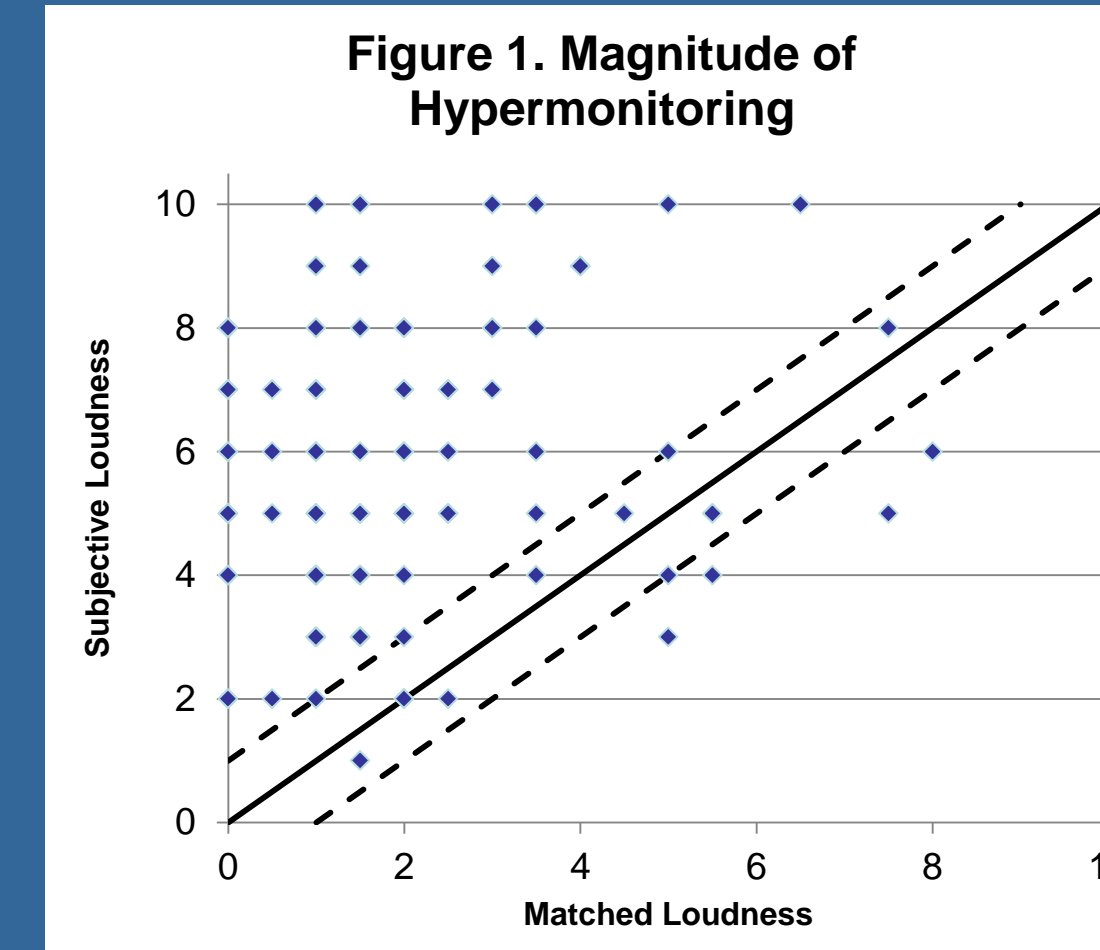
Figure 4. Does Low dBSL Mean Soft?

$R^2 = 0.0551$

Figure 4 shows a scatter plot comparing the patients loudness of their tinnitus match in dBSL vs. how loud they rank the match. The correlation is very poor indicating that dBSL is not a good indicator of whether a patients tinnitus is 'soft' or not.

A Scatter plot of Match in dBSL vs. Subjective loudness (not shown) was equally as poor.

DISCUSSION

This data review, based on programmed Serenade devices, aimed to determine if either the loudness of a patient's tinnitus match in dBSL or their subjective assessment of the loudness of their tinnitus was a legitimate means of assessing the loudness of their tinnitus. The concern of using dBSL values is that the patient may have a compromised loudness growth function. The concern with a self assessment is that the patient has a bias toward the tinnitus being perceptually louder due to subconscious effects.

While a tone that is pitch matched and loudness matched to a patient's tinnitus is not identical to their tinnitus, it can be said to be equivalent for the purposes of conducting a loudness assessment. Further, because it is perceived as not being the patient's tinnitus, it may be assessed without any emotional or subconscious bias.

As habituation occurs, the windows of time where a patient does not notice his tinnitus increase, and if he does notice it, it is less bothersome. Hypermonitoring and its correction may play a role in this.

The amount of hypermonitoring is not correlated with any of the other tested parameters including Threshold or Tinnitus Loudness in dBSL. This indicates that a separate test, such as the method outlined here should be used to determine tinnitus loudness.

These data show that the vast majority of patients being fit with a SoundCure Serenade device are perceiving their tinnitus as louder than they should. This may indicate both the means through which patients habituate, or get better (that is, the restoration of an appropriate perception), and may be a useful tool for patient counseling and useful in assessing sound therapy suitability. Future research is needed to verify both of these points.

CONCLUSIONS

- 85% of patients being fit with the SoundCure Serenade device perceive their tinnitus significantly louder than they should

- Using the magnitude of a patient's tinnitus in dBHL or their self reported level of tinnitus are both poor indicators of the loudness of the patient's tinnitus

- 82% of patients have tinnitus that matches to a level of 3 or lower potentially indicating a high degree of treatability. (The assumption is that truly softer tinnitus may be more treatable if the perceptual component can be removed. This will not be true for all patients)

REFERENCES

1. www.tinnitusarchive.org