Happiness is a state of *mind:* Music from a digital hearing aid

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INTRODUCTION

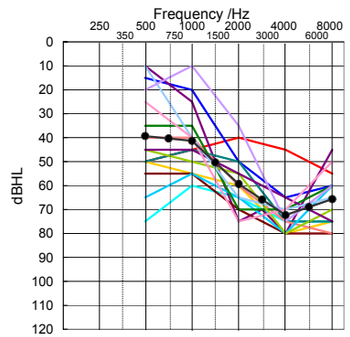
People with a hearing impairment have a higher incidence of stress than the normal hearing population (Fellinger et al, 2007). While obtaining hearing aids improves on quality of life 7-12% still experience a significant amount of stress (NCOA). These and other hearing aid users may enjoy the presence of relaxing background music produced by the hearing aids. The use of music to provide a relaxed listening background is supported by literature in the music therapy arena. Listening to music is a common strategy used to reduce stress, or increase relaxation. For example, Burns et al (1999) reported that music could result in physiological changes in the listeners resulting in relaxation and stress relief. Recently, a software algorithm in the mind440 digital hearing aid has been developed which generates fractal music composed of chime-like tones (Zen program). These tones are easily accessible by the hearing aid wearer through the push of a button on the hearing aid or via a remote control device. The current study was undertaken to demonstrate that the musical tones (1) are acceptable to hearing-impaired wearers and (2) provide a relaxing listening background to these individuals.

METHODS

Participants

- Fifteen adult participants 61 to 87 years (mean age = 73 yr)
  - Mild-to-moderately severe hearing losses (Figure 1)
  - Four females and 11 males were included
  - All were experienced hearing aid wearers
  - Participants were informed about the nature of the study (to evaluate acceptability of musical tones) and signed an informed consent prior to their participation.

Figure 1: Sensogram thresholds averaged for left and right ears plotted for each participant. Average thresholds for all participants are indicated by black circles.



Study hearing aids

- mind440 hearing aid in a micro-size (M4-m) behind-the-ear (BTE) model
- Zen listening program
  - Optional listening program that self-generates a musical chime background.
  - Zen may be used by itself (without amplification) or with amplification
  - Zen styles differ in major/minor key, tempo and pitch combinations.
    - The clinician and the wearer can adjust the intensity, pitch, and tempo of the tones so the sound may be the most desirable for the wearer.
- These features were activated during trials:
  - 15-channel wide dynamic range compression
  - Compression threshold as low as 0 dB HL
  - 15-channel fully adaptive directional microphone
  - Speech intelligibility index (SII) based noise reduction
  - Active feedback cancellation

METHODS (cont.)

Procedures

- Prior to testing participants were asked about their everyday use of music
- Participants were fit with the mind440-m monaurally with an instant fit foam ear-plug using standard fitting procedures (i.e., Sensogram and feedback test)
- Each person listened to 4 Zen styles at comfortable volume levels (determined with bracketing procedure) and default tempo/pitch and answered questions
  - Questioned on impressions concerning how relaxing each Zen style was
    - 5-point scale to indicate impressions (very relaxing, somewhat relaxing, neutral, somewhat tensing, or very tensing)
  - Participants were asked to circle words on a list of 24 adjectives, including positive and negative adjectives, to describe each Zen style (Figure 2).

Figure 2: List of descriptors participants were asked to consider in describing each Zen

peaceful	soothing	neutral	tensing
happy	depressing	drowsy	exciting
annoying	energetic	relaxing	calming
irritating	refreshing	indifferent	dreamy
solemn	uplifting	sleepy	aggravating
cheerful	tranquil	anxious	comforting

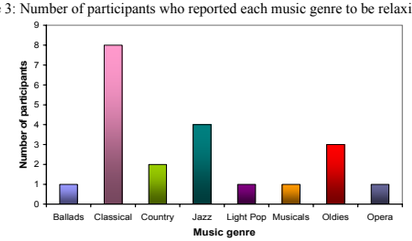
- Participants were given the opportunity to fine-tune their preferred style ("Zen optimized") by altering tempo and pitch settings using a Simplex procedure.

RESULTS

MUSIC APPLICATION IN DAILY LIFE

- Percentage of participants who reported background music to be relaxing: **80%**
- Percentage of participants who actively turn on music to relax them: **60%**
- Participants reported a variety of music genres to be relaxing (Figure 3).

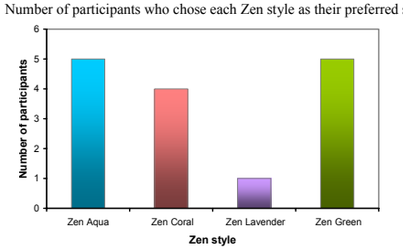
Figure 3: Number of participants who reported each music genre to be relaxing.



OPTIMIZED ZEN STYLE

- The majority of participants preferred either Zen Aqua or Zen Green (Figure 4).
- Tempo and/or pitch of the preferred Zen style was adjusted by 13 of the 15 participants (Table 1).

Figure 4: Number of participants who chose each Zen style as their preferred style.



RESULTS (cont.)

Table 1: Zen setting preferences for each study participant. Default settings are shown. Those parameters that remained at default are highlighted.

Participant	Pitch	Tempo	Volume
Aqua Default	**Low**	**Slow**	**7**
5	High	Medium	9
6	Medium-high	Fast	13
10	Low	Slow	15
11	High	Fast	12
12	Low	Slow	15
Coral Default	**Medium-high**	**Slow**	**7**
3	Medium-low	Medium	6
4	High	Medium	12
7	Medium-low	Medium	13
13	Medium-low	Slow	8
Green Default	**Medium**	**High**	**7**
1	Medium-high	Fast	6
2	Medium-low	Slow	7
9	Medium-high	Medium	12
14	High	Fast	5
15	Low	Medium	9
Lavender Default	**Medium-high**	**Fast**	**9**
8	Medium-low	Medium	13

RELAXATION RATINGS

- The majority of participants (**80-86%**) perceived the Zen programs to provide a relaxing background (somewhat relaxing or very relaxing) for the general population and for their own use (Figures 5 & 6).
- About **73-86%** of participants rated "Zen optimized", Zen Aqua, Coral, and Green as "very relaxing" and "somewhat relaxing".
  - Only **33-60%** of participants rated Zen Lavender as relaxing.
  - Between **53%** and **86%** of the participants rated all (5) Zen conditions to be "somewhat relaxing" or "very relaxing" for them.

Figure 5: Frequency of assigned ratings in each category (forced choice), including median ratings, for Zen styles in response to the question *"Would this be a relaxing background for most people?"*

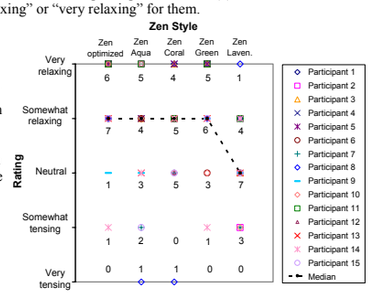
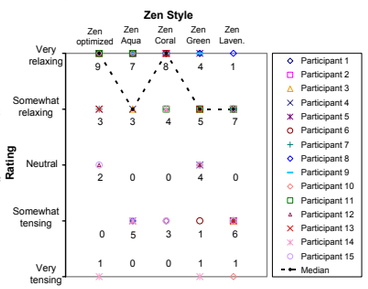


Figure 6: Frequency of assigned ratings in each category (forced choice) including median ratings for Zen styles in response to the question *"Would this be a relaxing background for you?"*

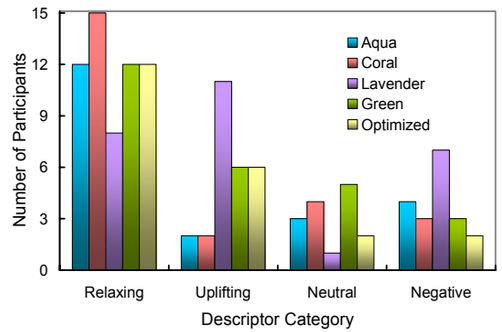


RESULTS (cont.)

PERCEIVED DESCRIPTIONS

- Twelve participants described "Zen optimized", Zen Aqua, and Green as relaxing.
- All 15 participants used at least one relaxing adjective to describe Zen Coral (Figure 6).
- Zen Lavender was described as "relaxing" by only 8 participants.
- Zen Lavender was described with the most number of "uplifting" and "negative" descriptors. Zen Lavender was found to interfere with relaxation, most likely due to its faster tempo.

Figure 6: Instances in which at least one adjective was selected in a descriptor category for each Zen style.



CONCLUSIONS

- A majority of participants perceived background music to be relaxing
  - Preferred genre, tempo, and pitch varied between listeners
- Zen tones have the potential to provide a relaxing listening background for the majority of listeners.
  - Aqua and Green are good places to start although preferred Zen style and parameters vary between individuals.
  - The "Zen optimized" styles obtained the highest relaxation scores.

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