BREATHING MUSIC
A Study on the Synchronization of Music and Breath

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INTRODUCTION

In recent times, there has been an increase in "meditative music" or "relaxation music." However, there has been little research exploring the effectiveness of the music's compositional elements. **Sound frequency** is an emphasized element of this type of music. For this reason, we selected **frequency**, along with **beat** and **instrumentation** as the three primary components of music to study and test their effect on relaxation.

In this pilot study, we used our original music's beats and frequency ranges to test the effect it has on relaxation, as well as received feedback on the music's chosen instrumentation. The beat of the music was set to a constant rate due to its entrainment effect on respiratory rate (RR). Frequency was selected as a focal parameter of this study, as it is possible that certain frequency ranges have consistent effects on listeners. By finding out the optimal beat and frequency for a listener's relaxation, along with the feedback on instrumentation, we hope to create an original, effective relaxation music album based on our findings.

We call this music "Breathing Music."

PURPOSE

To test the effects that music, composed with consistent beat and different frequencies, has on a listener's respiratory rates and anxiety levels.

AUDIO AID

Please visit during the poster session to listen to a sample of the audio we are using.

Track 1 - 1000-2000Hz
Track 2 - 500-1000Hz
Track 3 - 250-500Hz
All music is loop-able, 96BPM (12 beats), and exactly one minute in duration.
Instrumentation is entirely made up of digital synth instruments.

METHOD

Music

Three original pieces of music (referred to as "tracks" from here on) were composed. The guidelines for the composition process kept three main musical components in mind: beat, frequency, and instrumentation.

- Beat
  - We defined relaxation as : decrease of respiratory rate (RR) due to the connection of breathing pattern and mental status that past research has shown[1]. More specifically, we defined relaxation tendency as decrease of RR of 1 breath or more/min.
  - Based on the fact that the average adult RR at rest is 14 breaths/min, we set the beat of the music to be slower than this rate for entrainment, and selected the number 12 beats/min that is compatible with creating music in blocks of 60 seconds (or multiples of 12).
  - 12 equidistant "beats" were used as key points in each one minute track and at each of these beats, subtle sounds are played, in order to subconsciously influence the listener
  - Each track is also loop-able, meaning that the music can be played back repeatedly without any awkward cuts or pauses during continuous play through.
- Frequency
  - Three frequency ranges were selected to limit each track's sonic quality. Because it was already assumed that high frequency ranges that are associated with sirens, alarms, and screaming would not be pleasant, the selected frequency ranges were in the lower part of the frequency spectrum.
- Instrumentation
  - The instrumentation used in all three tracks are digital synth sounds. The reason for this is due to the lack of personal association the average person has with these sounds. If, for example, someone had a bad experience with guitars, it would distract that person from the music as a whole and create a variable in the experiment process.

Subjects

- Case studies: N=4 (1 male, 3 females, average 30 years old)

Measurements

- Spielberger State-Trait Anxiety (STAI) was used to measure trait and state anxiety
- Each subject was asked complete STAI before and after music exposure to measure baseline trait/state anxiety and post music exposure state anxiety
- Subjects were strapped with a chest band and given headphones
- Subjects were asked to sit down and close their eyes throughout the experiment
- After baseline rest stage RR was measured, tracks 1, 2, and 3 were played in a random order (1 minute each), with rest in between
- RR during rest stage and during music exposure were measured
- Subjects were asked to answer the following questions at the end of the experiment:
  - "Did you prefer a certain track?"
  - "Did you notice and looping in any of the tracks?"
  - "Did you notice any specific instruments in any of the tracks?"
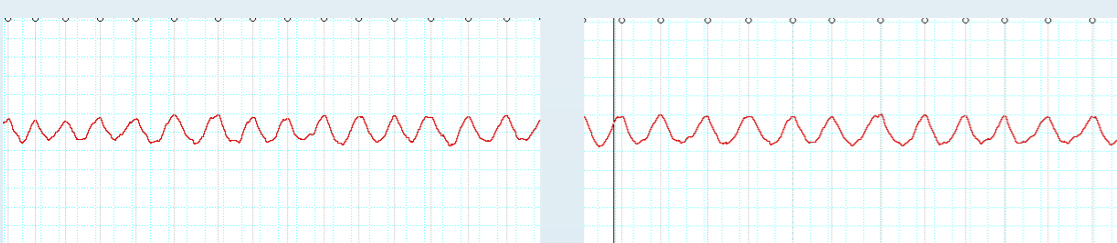
Subject 4: Rest RR

Subject 4: Music 3 RR

Subject 3 listening to Breathing Music with PowerLab and chest band

Set Up

- Music was composed with Logic Pro X and Omnisphere (synth/sampler)
- Headphones (beyerdynamic DT770 Pro 80ohm) were connected to the PC for music sound
- Subjects wore headphones for music exposure, and a chest band that was connected to the PowerLab to measure RR
- Due to the restrictions of the lab, subjects (and staff) were asked to wear masks at all times

RESULTS

STAI	Gender	Age	Pre-Music Trait	Pre-Music State	Post-Music State
Subject 1	Female	31	34	38	30
Subject 2	Female	34	42	43	36
Subject 3	Female	35	32	24	20
Subject 4	Male	23	37	37	26
Average		30.75	36.25	35.5	28

Respiratory Rate	Rest stage (no music)	Track 1 (1000-2000Hz)	Track 2 (500-1000Hz)	Track 3 (200-500Hz)
Subject 1	21	19	19	19
Subject 2	19	17	17	17
Subject 3	12	12	13	12
Subject 4	16	13	14	12
Average	17	15.25	15.75	15

- All subjects responded positively to all 3 tracks: said they felt relaxed and that music was pleasant.
- No particular preference of tracks was indicated except in Subject 4 who preferred Music 3.
- None of the subjects felt that the music looped in any way.
- No recognition of, nor distraction from any particular instrument occurred.
- Additional comments were made regarding the length of music exposure - that when music abruptly stopped after its full minute - they felt "lost, and did not know where to focus their attention to." This indicates that perhaps exposure longer than 1 minute could be more effective.

DISCUSSION AND CONCLUSION

After exposure to all three tracks, there was an overall decrease in state anxiety levels indicating that the music had an effect on relaxation. There was also an overall trend for decrease in RR during music exposure, but the degree of change seems to vary among subjects when comparing the three tracks amongst each other. This suggests the influence of "personal preference" occurs with each person when listening to music in general. Furthermore, because the rhythm of the tracks are set to 12 "beats" per minute, this may explain why Subject 3, who started at the RR of 12 breaths per minute did not experience much change throughout music exposure. Based on the feedback from Subject 4 who expressed preference for track 3, which also coincided with the most change in RR, it is possible that music within a certain frequency range is subjectively preferred by the listener, and could result in triggering relaxation the most effectively.

Feedback from subjects also suggests that exposure to music for 1 minute may be too short, and that fading out the audio could be a better way to end exposure during experimentation. Feedback also shows that there was no recognition in neither looping nor instrumentation, meaning that there are no compositionally distracting elements within the music that could potentially influence the listener. Subjects also did not mention the beat of the music being too fast or slow, meaning that the 12 breaths per minute foundation was not a hindrance to the listener during music exposure.

Overall, this pilot study suggests that our original music set to this beat is effective for relaxation, but no significant difference was seen among the three tracks of various frequency ranges. Personal preference seems to be a factor that affects the tracks' degree of effectiveness for that person. In order to find the optimal frequency range(s), further experimentation must be conducted with more test subjects. However, because all three tracks were found to be relaxing and pleasant by subjects, no further division of frequency ranges or changes in music composition is necessary for future testing.

By conducting this experiment on a larger scale with more test subjects, the most effective frequency ranges can be used for an original album of "Breathing Music." The goal is for our "Breathing Music" is for it to be complimentary to breathing exercises, support clinical settings, and be useful as a relaxation tool in various settings such as flights, waiting rooms, or at home.

SUMMARY

- A decrease in state anxiety after music exposure was observed in all subjects
- A decrease of RR ranging from 2-4 breaths/min was observed in 3 out of the 4 subjects during music exposure
- Subject 3 showed no change in RR during music exposure, and remained at 12 breaths/min during both rest stage and music exposure (except during track 2, where there was 1 breath/min increase)
- There were no remarkable differences in the change of RR in 3 subjects when the 3 tracks were compared within each case subject
- Subject 4 showed a different response for each of the 3 tracks (RR change ranging from 2-4 breaths/min), perhaps suggesting that "personal preference" of music could be a factor for effectiveness. This was confirmed at the end of the experiment (Subject indicated that track 3 was most preferred, which had the most change in RR)

Reference:
[1] Breathing rhythms and emotions. Homma I, Masaoka Y, Exp Phisiol 93.9 pp1011-1021