A Study on User Acceptance of Different Auditory Content for Relaxation

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ABSTRACT
The use of auditory interface at the relaxation-assisted interactive system is becoming increasingly popular. This study aims to investigate the effects of different types of auditory content on the subjective relaxation experience. The participants listened to fifteen sound samples from five categories: (a) nature white noise, (b) natural soundscape, (c) ambient music, (d) instrumental music, (e) instrumental music mixed with the natural soundscape. These auditory contents were selected or designed specifically for assisting relaxation. The study measured the subjective relaxation rating after listening to each sample and interviewed the listeners to understand what causes the differences in relaxation experience. The results indicate that the instrumental music and the combination of nature soundscape and music might be a better auditory content or audio form to induce relaxation compared to the ambient music, pure natural soundscape, and nature white noise. The findings of this study can be used in the design of musical and auditory display in many interactive systems for stress mitigation and relaxation exercises.

Keywords
Nature sounds; Music; Auditory interface; Relaxation; User experience

ACM Classification Keywords
H.5.1 [Information interfaces and presentation]: Multimedia Information; H.5.2 [Information Interfaces and Presentation]: User Interfaces

1. INTRODUCTION
The auditory interface is widely used for the relaxation-assisted system; since it liberates users from visually focusing, allows them to close the eyes and improves their focus and comfort. Harris et al. [1] developed an auditory biofeedback system that encourages slow breathing. The system adjusts the quality of a music recording in proportion to the user's respiration rate. *Sonic Cradle* [2] offers the users an immersive experience, where they could shape a peaceful soundscape by regulating their respiration. In [3], the authors proposed auditory respiratory biofeedback by adapting the music quality (e.g., signal-to-noise ratio) to promote slow and deep breathing.

Music is frequently used in relaxation exercises as a background accompaniment because they are believed to be effective in calming down, reducing negative emotion and enhancing relaxation. Therefore, many researchers explored applying the form of music into the human-computer interface design for relaxation-assistant biofeedback systems [3-4]. Besides, nature sounds are also perceived as pleasant components of a sound environment and used as feedback to support interaction [5]. For instance, Eggen et al. [6] used the birdsongs as a type of peripheral display to communicate information about the activity in the office.

Many researchers have investigated the relaxing effect of different music genres, such as stimulative vs. sedative [7], classical vs. self-selected [8] and classical vs. New Age [9]. Stratton et.al [10] also explored the role of music in relaxation by comparing five types of music regarding the pleasurable quality of the experience, ability to empty the mind, and liking of the music. However, to our knowledge, most of these studies focused only on music, not on other auditory content, such as nature white noise and natural soundscapes. For instance, some ambient music, the sound of rain and the soundscape of forest are often applied to create a pleasant acoustic environment for relaxation; few researchers have explored the listener's relaxing experience with these auditory content.

In this study, we aim to investigate the effects of different types of auditory content on the relaxation experience. The findings of this study might be a reference regarding the selection of the auditory content or forms in the design of the interface which aims to promote relaxation. We broadly divided the sounds or music that are commonly used for relaxation into five categories: nature white noise (NN), natural soundscapes (NS), ambient music (AM), instrumental music (IM), and the combination of instrumental music and natural soundscapes(IMNS). Each category consists of three sound samples. Each participant

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listens to a total of 15 sound samples in the experiment. We measure the self-reported relaxation rate after listening each sample and conduct a post-listening interview after all listening tests to recognize the listeners' overall preference and opinions about different sound categories. We analyze the results both in a qualitative and quantitative way to understand what causes the differences in the relaxation experience and discuss how these findings can be used in the auditory interface design regarding relaxing experience.

2. RELATED WORK

White Noise in sound is created by a continuum of frequencies equally distributed over the whole hearing range. In healthcare applications, the white noise is used to treat hyperacusis or to camouflage the annoyance caused by tinnitus [11]. The natural source of white noise might be a natural phenomenon that creates multiple frequencies; resulting in a sound that listener may find soothing, such as the sound of rain, fire, and wind. Nature white noise is commonly used to mask background noises in the office [12] or to aid in focus or sleep [13, 14].The work in [15] demonstrate that the listener's moods and the ability to focus improved when exposed to nature white noise.

A natural soundscape refers to a natural acoustic environment consisting of various sounds created by nature (geography and climate): wind, water, forests, plains, birds, insects, or animals. The keynote sounds in a natural soundscape "*outline the character of the people living there*" [16]. Many nature sounds are typically perceived as pleasant components of a sound environment [17, 18] and used for coping with stress. For instance, the birdsong and sound of rain have shown a positive emotional effect [19]. And a mixture of sounds from a fountain and tweeting birds have also demonstrated stress-relieving effect via the autonomic nervous system [20].

The concept of ambient music was developed in the 1970s, stemmed from the experimental and synthesizer-oriented styles of the period. Different from the classical music with a perceptible melody or rhythm, ambient music usually focuses on creating a mood or atmosphere through synthesizers and timbral qualities. Ambient music is generated by modulating tonal sounds and sonic textures, allowing the listeners to identify a particular musicality but without any melody or tempo [21]. As the rhythmic nature of music will impose its tempo or rhythm on listener's body [22], such as heart rate or breathing; the absence of a musical pattern in ambient music leaves much freedom to the listener's feelings. Space music is a subgenre of ambient music, which is intended to create a sense of "continuum of spatial imagery and emotion," beneficial introspection, deep listening and sensations of floating, cruising or flying [23]. Ambient music, especially space music are also widely used to stimulate relaxation, contemplation, inspiration and meditation [24].

For many people, music is a source of pleasure, a great mood booster. A fast and dynamic musical piece may have an excitative effect while a melodious and slow ones have a sedative effect. Music listening can powerfully evoke emotions [25] and influence the heart activity, blood pressure, respiration and the activity of autonomic nervous system [26-28]. Several researchers [29-31] suggest that relaxing music helps to reduce subjective anxiety and physiological stress, particularly sedative music, which is characterized by a slow tempo of 60 to 80 beats per minute (bpm) with a soft dynamic range [32].

Some composers also integrated nature sounds into their music for a more relaxing listening experience. For instance, in new-age music, the nature sounds are used as backgrounds for various musical soundscapes, or modified with reverbs and delay units for creating the ambiance. Goel and Etwaroo [33] found that listening to birdsong accompanied by music reduced self-reported negative affect. This combination was also reported to be effective in decreasing pain and anxiety in cardiac surgical patients [34] and those with cancer on hospice [35]. Some teachers also combined the smooth sound of music with nature sounds to create a pleasant learning environment [36].

3. SOUND SELECTION

The collection covered five categories: Nature White Noise (NN), Natural Soundscapes (NS), Ambient Music (AM), Instrumental Music (IM), the combination of Instrumental Music and Natural Soundscapes (IM-NS). Each category includes three different samples, and this is intended to counteract the effects of listeners' preference for a particular piece of sound and music. A collection of 15 pieces of sound samples was created from sound materials listed in Table 1. Each sound sample lasts 120 seconds and is normalized to the same volume level.

3.1 Nature White Noise selections

Nature white noise selections were the sounds of rain, fire, and water stream, which are all common natural sources of white noise. Rain provides excellent white noise for concentration, relaxation and falling asleep. Compared to the rain, the sound of fire offers sharper transients (the crackles) and a darker and warmer level of white noise. The soothing sound of a flowing water stream is ideal for blocking out environmental noises and distractions.

3.2 Natural Soundscapes selections

The selection of the natural soundscapes was based on a pre-test user survey, which was designed to collect the user's opinions on which nature scenes would make them feel relaxing. The responses from 40 participants suggest that the most-frequently mentioned relaxing nature scenes were *"lying on the beach in the sunset," "wandering into a forest or a grassland," "looking into starry night"*, and *"walking in a mountain along a riverside."* Based on these feedbacks, we created three natural soundscapes, namely "Peaceful night", "Mountain stream", and "Rainforest". Each soundscape consists of three nature sounds appearing with different frequency, namely low, medium and high

frequency. We assume that the sound appearing in high frequency will be perceived as the keynote sound in the soundscape. For instance, in the soundscape of "Rainforest", the sound of rain acts as the keynote sound; a large number of rain drops sound like white noise, covering a high-frequency range. The birdsongs are played at medium frequencies, and the sounds of frogs arise only occasionally.

Table 1: Sound selections

a). Nature White Noise (NN)	a1. the sound of rain a2. the sound of water stream a3. the sound of fire
b). Natural Soundscapes (NS)	b1. Peaceful night (the wind, insects, cicada) b2. Moutain (water, birdsong, doves) b3. Forest (rain, birdsong, frogs)
c). Ambient Music (AM)	c1. Frequency-shaped tonal sounds c2. Frequency-shaped meditation music c3. Trance-inductive space music
d). Instrumental Music (IM)	d1. Piano Music (*"Satie's Gymnopédie No. 1"*) d2. Anasazi Flute Music ("*Coming Home"*) d3. Guitar Music (*"Easy Day"*)
e). Instrumental Music with Nature Soundscapes (IM-NS)	d1+b1, d2+b2, d3+b3; d1+b1, d2+b3, d3+b2; d1+b2,d2+b1, d3+b3; d1+b2, d2+b3, d3+b1; d1+b3, d2+b1, d3+b2; d1+b3, d2+b2 , d3+b1;

3.3 Ambient Music selections

In our study, we selected three pieces of ambient music created by *myNoise*[1]. Each piece of music consists of multiple tonal layers, from sub-bass, low bass, bass, high-bass, low-mids, mids, high-mids, low-treble, treble, to high-treble. These pieces are characterized by sustained and synthesized tones, accompanied by the sounds such as a subtle hum, a haunting flute or sparkling bells. Slow and freely flowing rhythm, little dynamic contrast and lack of percussion give the music an overall calming, tranquil and dreamy feeling.

3.4 Instrumental Music selections

Three pieces of instrumental music, a piano, guitar and flute solo, were used in the study. The first piece of music was *Gymnopédie No. 1*, a piano composition by Erik Satie. The second piece of music was *Coming Home,* a piece of Anasazi flute by Terry Bradley. The third piece was *Easy Day* in *Beautiful Life* by Ferenc Hegedus. These pieces of music are widely acknowledged or used as a sedative music and characterized by flowing melody and steady rhythms. Such type of music has been used in the study [37], the results of which have shown that it reduces stress and enhances the relaxation.

[1] myNoise, http://mynoise.net/

3.5 Instrumental Music mixing with natural soundscapes

We got nine combinations of instrumental music and natural soundscapes. To counterbalance the stimulus of combinations (ensure that the listener does not listen to two instrumental music with the same natural soundscape), we made six groups of combinations, each of which contains three combinations. Accordingly, thirty participants are randomly divided into six groups, each group receives one group of combined sounds, as shown in Table 1. In the mixing of the soundscape with the music, we normalized the volume of the soundscapes to 30 percent of the music volume. The idea here is to enable the instrumental music could still be perceived as the main sound while the natural soundscapes serve as the background sound.

4. METHOD

A within-subjects experiment design was used to assess the effects of five categories of sounds on subjective relaxation experience. The independent variable is the type of sound or music, and the dependent variable is the self-reported relaxation experience. Each subject listened to 15 sound samples in a counterbalanced order. Study participants were unaware of the specific aims of the study and the predicted effects of the different sound. They were not told the name of any of the sound selections.

4.1 Subjects

Thirty participants took part in the study through informed consent procedures. All participants were volunteers. They were randomly selected from a variety of undergraduate and graduate classes. The 15 males and 15 females ranged in age from 22 to 33. There was a wide range of reported daily music listening time, from no time spent to more than 2 hours. Because people with extensive music training may respond differently than non-musicians to musical stimuli, those with a formal background in music were excluded from the study.

4.2 Measures and apparatus

Measures included a background questionnaire, Relaxation Rating Scale (RRS) [8] and a post-listening ranking and open question interview. The background questionnaire consists of three questions relatively about daily music listening time, the habit of listening to the music, and the taste in music. In this study, each participant will listen to 15 sound samples. The short exposure (2 minutes) to each sound sample is not enough to affect the stress state of the listeners. Besides, the stress measurement such as State-Trait Anxiety Inventory would take too long to complete. Therefore, we used the relaxation rating scale which only requires the participant to rate his/her level of relaxation on a Likert-type scale with one being ''not relaxed at all'' and nine being ''totally relaxed'' by circling the number that best described his/her experience of relaxation. Higher scores indicate that the participant is more relaxed. A small

testing room furnished with a recliner chair, rug, lamps, and audio equipment was used. A 40-W floor lamp softly lighted the room. The music was played through an acoustic noise cancelling headphones (*Bose, QuietComfo*rt 25) at a fixed volume of 7 on a Mac computer.

4.3 Post-listening Interview

Individual interviews with each participant were conducted after all sound samples listening. The interview was intended to obtain deep understandings of user preference and subjective experience towards each sound category as a whole; the feedback and insights could be applied in future sound design for mind-body practice. Before the interview, the participants were informed the names of all sound samples and sound categories; then they were given some time to recall the listening experience with different sound samples. The participants then ranked each sound category as a whole based on their preference in the context of relaxation. Finally, we asked participants questions about their rankings. The example of the question might be "*could you tell me the reason you choose instrumental music as the first choice?*"

4.4 Procedure

All subjects were tested individually. Before the sound-listening session, each subject completed the background questionnaire (lasting approximately 5 minutes). Then, the participant was seated in the recliner with comfort and relaxed for 3 minutes. The participants were told to finish the relaxation rating scale based on the current relaxation experience as the baseline. After that, they were asked to put the headphones on and relax while listening to the sound. The researcher started to play sound samples one after another. The sound faded in and out in each sound-listening test to ensure a comfortable listening experience. After listening to one sound sample, the subject immediately finished the RRS. When all sound-listening tests were completed, the participant was instructed to have a post-listening interview.

5. RESULTS

5.1 Quantitative Results

The analysis of variance was conducted to determine the effects of the different sound types (*NN, NS, AM, IM, IM-NS*) on the subjective rating of relaxation experience. See Table 2 for means and standard deviations of the Relaxation Rating Scale towards each sound and sound category. Firstly, one-way ANOVA analysis was conducted between sound samples in each category and also between sound categories. Furthermore, based on the background questionnaire, we divided the participants into two subgroups based on their daily music listening time: active music listener group who spend more than 1 hours listening to music per day and inactive music listener group. Then, We did the analyzes of the subgroups.

Table.2. Relaxation Rate Scales on each sound sample

Sound Types	*No.*	*Sound*	*Means*	*SD*	*Means*	*SD*
Nature White Noise	S1	Rain	6.10	1.75	5.33	1.36
	S2	Water	5.03	1.85		
	S3	Fire	4.87	2.11		
Natural Soundscape	S4	Night	5.10	1.92	5.51	1.33
	S5	Mountain	6.47	1.33		
	S6	Forest	4.93	2.21		
Ambient Music	S7	AM1	4.43	1.90	4.91	1.35
	S8	AM2	6.40	1.61		
	S9	AM3	3.97	2.39		
Instrumental Music	S10	Piano	7.23	1.30	7.10	1.0
	S11	Flute	6.83	1.46		
	S12	Guitar	7.23	1.22		
Music mixed with Nature Soundscape	S13	Piano+NS	7.03	1.56	6.93	0.92
	S14	Flute+NS	6.77	1.25		
	S15	Guitar+NS	7.00	1.29		

5.1.1 Compared with pre-listening relaxation state

The results in Table 2 indicated that with all six sound samples from IM group (7.10±1.0, $p<0.001$) and IM-NS group(6.93±0.92, $p<0.001$), the participants reported a significant increase in their relaxation rating. In general, the sounds from NN (5.33±1.36, $p=0.86$), NS (5.51±1.33, $p=0.57$) and AM (4.91±1.35, $p=1.0$) did not significantly affect the participant's subjective ratings on relaxation. Specifically, a significant increase was only observed with the soundscape of "mountain stream" from NS group ($p=0.026$) and frequency-shaped meditation music (AM2) from AM group ($p=0.011$).

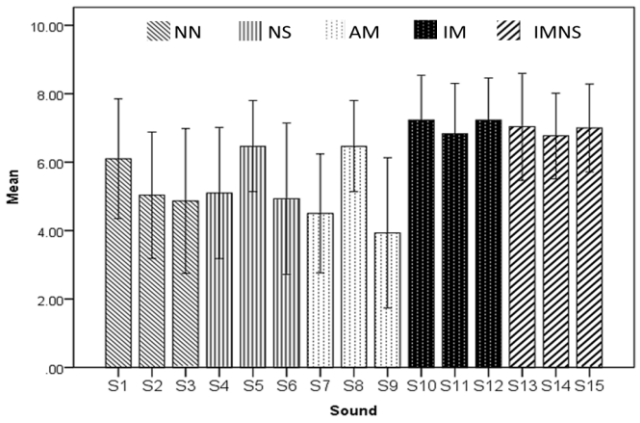

Figure 1. Relaxation Rate Scales on each sound sample

5.1.2 Between sound categories

There was a significant difference between sound categories as determined by one-way ANOVA ($F(2,27)$ =

18.97, p <0.001). A Tukey post-hoc test revealed that the relaxation rating on IM group and IM-NS were both significantly higher than NN (5.33±1.36 scores, p<0.001), NS (5.51±1.33 scores, p<0.001) and AM (4.92±1.50 scores, p<0.001) groups. There were no significant differences between the IM and IMNS groups (p=0.985).

5.1.3 Within each sound category

As shown in Figure 1, there was a significant difference among sounds within NN group ($F(2,27)$=3.69, p=0.029). The rating on the sound of rain was significantly higher than the sound of fire (4.87± 2.11, p=0.037). In NS group ($F(2,27)$= 6.16, p=0.003), the rating on the soundscape of 'mountain stream' was significantly higher than the 'Night' soundscape (5.10±1.92, p=0.015) and the 'Rainforest' soundscape (4.93± 2.21, p=0.05). In the AM group, the ratings on the second music (Frequency-shaped meditation music) was significantly higher than the first music (4.43± 1.90, $p=0.001$) and the third one (3.97± 2.39, p<0.001). In IM group and IM-NS group, there were no significant differences among sound or music samples.

5.1.4 Active listeners vs. Inactive listeners

The differences between the active music-listening and inactive music-listening subgroups were shown in Figure 2. In both subgroups, the ratings on IM and IM-NS were both significantly higher than other three sound categories. With the ambient music, the active music-listening group showed high ratings on relaxation, but the difference was not significant (F(2,27)=3.51, p=0.071).

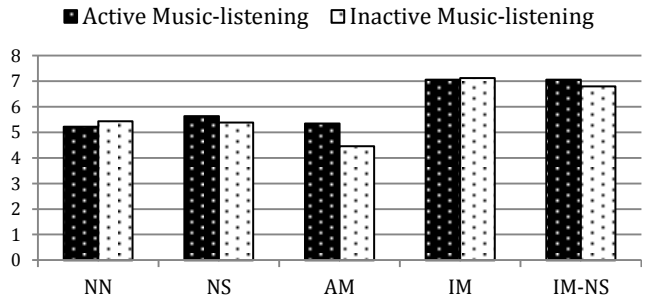

Figure 2. Relaxation Rating Scores, Active music-listening vs. Inactive music-listening group

5.1.5 Post-listening overall ranking

The results of post-listening rankings show the listeners' general opinions about five sound categories. See figure 3, 12 participants chose the IM as their favourite for relaxation, and 11 participants chose IM-NS. Regarding the second choice, IM and IM-NS still received the majority of votes, namely eight votes and 12 votes. Most participants were neutral toward NS, where six votes for the second favourite, 14 votes for the third place and six votes for the fourth place. The votes for NN group are distributed more widely and evenly; the 1st choice received five votes, and the 3rd, 4th and the last choice received eight votes equally. AM received the worst rankings, where 9 participants ranked it as the penultimate choice and nearly half of participants selected it as their last choice. The results of ANOVA analysis indicate that the rankings on IM and IM-NS categories are significantly higher than other three categories ($F(2,27)$=13.44, $p<0.001$).

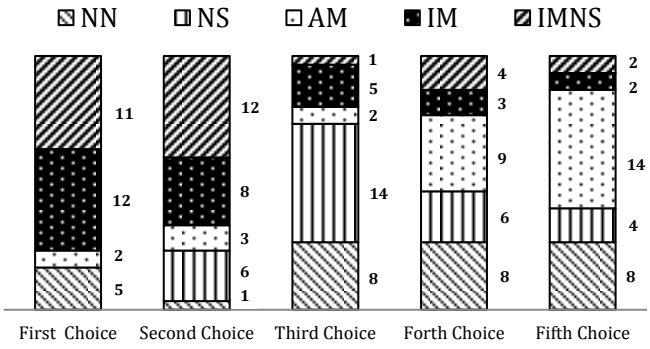

Figure 3. Rankings by participants on five sound categories

5.2 Qualitative Results

5.2.1 Nature white noise & natural soundscape

In both categories of nature white noise and natural soundscape, we found the participants' preference for a particular nature sound or nature environment varies widely. We argue that there is a significant correlation occurred between liking and relaxation experience. When the listener likes a specific nature sound, there is a high likelihood of a strong relaxing experience and vice versa. For example, one participant who ranked the rain sound as her favourite commented that *"I like rainy days. The sound of rain makes everything outside look more calm and quiet and also makes me feel relaxing."* meanwhile, another said, *"the sound of rain reminded me of the bad weather when I was caught in the rain on my way to work."*

Listening to soundscapes enriched the experience in other senses, such as some feelings described in the interview *"the warmth of the sunshine," "the heat of a bright afternoon,"* and *"a gentle breeze blowing."* These pleasant experience might enhance relaxation. One participant mentioned that *"the soundscape of the water stream, bird songs, and doves is very relaxing, give me a feeling of peace."* We found that the same soundscape might also be perceived differently. For instance, the soundscape of forest could be perceived as a relaxing situation as described as *"sounds like walking in the woods with fresh air"*, but also as a dangerous one, *"It makes me feel like I am exploring in an unknown place alone."* Moreover, because a soundscape may consist of a variety of nature sounds, the relaxation experience is easier to be influenced by the individual' preferences on a certain nature sound. Some participants mentioned that they like the "forest" soundscape, but they dislike the sound of frogs, which seriously reduce their experience. For part of participants who ranked natural soundscape low, they thought it was distracting and

annoying as a whole when all sound elements in the one soundscape are all become louder.

5.2.2 Ambient Music

The feedbacks from the interview show that most ambient music created a particular atmosphere that stimulates the participants' senses, but these enhanced feelings had no significant positive effect on relaxation. With the ambient music, most participants reported a feeling as if they were floating in space or on air. However, for some participants, especially most female participants, the scenes or feelings evoked by ambient music tend to be *"cold"*, *"dark"*, *"alone"* and even *"lifeless*", and this increased their sense of insecurity and tension instead of relaxation. The participants described their feelings like these: *" the drumbeats made me feel more worried;" "this made me dizzy;" "Scary, not relaxing;" and "The sound creep me out."* However, the participants who prefer that ambient music suggested that the lack of structured melody, rhythm or beat make the music less predictable, which enables them to focus more on their breathing and body.

5.2.3 Instrumental Music

Instrumental music enhances the relaxing experience by evoking positive emotions, happy memory or beautiful imaginations. Most participants ranked instrumental music as the most relaxing sound type, and they reported when listened to the music, some visual imageries of nature and episodic memories came to the mind, which made them feel pleasant and relaxing. In the interview, they mentioned that: *"the smooth flute music made me think of an image of an idyllic scene of cows and rolling hills," "The guitar I just heard reminds me of my high school days." "It reminds me of the happy hours I spent with my friends."* Some participants also suggested that the selected music stirred their emotions: "*the piano music made me feel relaxing but a bit sad."* Most of the memories, visual imageries and emotions were positive, such as "*pleasant"*, *"beautiful" and "happy"*.

5.2.4 Combination of Music and Nature Soundscape

Compared to the purely instrumental music, the participants' opinions on the combination of music and natural soundscape were a bit different. The participants who selected the combination as their favourite suggested that the natural soundscape quickly visualized a nature scene in their mind. The imaginary nature scenes made them feel like they were in another world, such as being *"on vast grasslands"* or *"in a verdant forest."* And the music which goes with the nature scenes enhances the feeling of relaxation. However, a few of participants prefer the purely instrumental music for two reasons. When the visual imageries evoked by the music is inconsistent with the imaginary nature scene created by natural soundscape, this combination will weaken the relaxing effects of playing one of them alone. Take the Anasazi flute music as an example; one participant mentioned the music gave her a visual imagery of *"gently rolling hills covered with orchards in the sunset"*, but when it was mixed with nature soundscape of the forest, the nature sounds instead became a big dissonance in the music. Another reason was that for some listeners, the mixture might produce a particularly fragile sound in the melody of the music and the harmony of the natural soundscape.

6. DISCUSSION

The results of this study show that participants perceive more relaxation after listening to the instrumental music or listening to the music accompanied with natural soundscape than other three categories. Listening to the natural soundscapes are also partially perceived to be more relaxing. However, with nature white noise, most participants reported no improvement in their subjective relaxation compared to before listening. There is a large variation in the relaxation ratings on ambient music; some listeners were even more anxious after listening to a particular piece of ambient music. It is possible that the personal taste in music or preference on nature scene has a strong influence on subjective relaxation experience.

Although nature white noise has been used in a wide variety of relaxation-assisted products, website, and application, such as *MUJI to relax*[2], there are few studies to verify its effect on relaxation. In [36], the researchers suggested that nature white noise is effective in improving the mood and performance of workers by masking background noise and promoting a focused state. In our study, we did not find strong evidence that nature white noise can induce relaxation effectively. The results suggested that the relaxation experience largely depends on how a user like nature sounds subjectively or emotionally.

The listeners had significantly different attitudes towards ambient music regarding relaxation experience. We selected three pieces of ambient music that are close to the style of space music. As claimed in [23] by Hill, space music can evoke a "continuum of spatial imagery and emotion," and the evoked feeling or sensations of flying and floating would be beneficial for relaxation. The feedback from interviews partly confirmed this view. Most participants described their feelings like "*floating in space, in the air or on the water*." However, we found no evidence that these 'the sensation of floating' would contribute to the subjective relaxing experience. Instead, a feeling of loneliness, insecurity and restlessness might be increased with ambient music. And we think that the evoked spatial imagery and enriched sensations by ambient music could be well used in sound installation design.

Our assumption was that the combination of natural soundscape with instrumental music would bring a more relaxing experience to the listeners. The sounds of nature are thought to be effective in minimizing individuals' perception of unpleasant noise in the environment,

[2] MUJI to Relax, MUJI to Sleep: http://sleep.muji.net/

providing individuals with a perceptual reality that is soothing and comforting. The musical parts can be created to enhance harmony and evoke positive emotions. However, in this study, the natural soundscape mixed with the music does not increase the participants' relaxing experience compared to pure music. We think there are three main explanations for this. The first reason might be the disharmony or mismatch between nature acoustic environment of soundscape and the visual imageries evoked by music. As suggested in the literature [38, 39], the music could evoke visual imagery. The natural soundscape could also create the sensation of experiencing a natural acoustic environment or an imaginary nature scene [19]. Therefore, only when the nature scene goes with the music, they are mutually reinforcing.

Adding nature sounds into music to enhance the listener's emotions and relaxation experience has been explored for many years, such as in the creation of New-age music. The new-age music combines the instrument sound such as flutes, piano, acoustic guitar with a wide variety of ambient sounds. We went back to some pieces of New-age music which integrate nature sounds with instrumental music. For instance, Dean Evenson combined his peaceful flute music with the sounds of nature in 1979. The recent example could be the album "*Headwaters - Music of the Peel River Watershed*" by Matthew Lien, in which the sounds of the watershed was composed and assembled into the music. We found that in these pieces of music, it is not simply overlaying the nature sounds onto instrumental music. The nature sounds are carefully selected and arranged by the composer as the essential integrant of the music. For example, when selecting a particular bird song, it should be considered that whether it is convenient to fit within a melodious musical form or a musical model. Finally, we also found that this mixture could easily produce a particularly fragile sound in the melody, which sounds too complex and even noisy. Therefore, another obstacle facing the use of natural soundscapes in music is their complexity.

The participants were exposed to 15 sound samples in five categories to counteract the effects of listeners' preference in sound or music, but this restricts listening time for each sample to 2 minutes. We argue that extending the time listening to music might allow us to be more confident about our results. The 2-minute listening time is too short for valid physiological measurements, such as respiration and skin conductance. Therefore, physiological measurements were not taken in this study. As suggested in [8], the assessment of heart rate, respiration and skin conductance could give more objective data on the arousal changes and relaxation responses with the music. Also, we suggest that, in the future research, stressing the participants before listening to the music might create a better measure of the participants' relaxation feeling as it might result in a greater range of emotional and physiological responses that could be potentially affected by different music types.

7. CONCLUSION

This study presents a rationale for the use of different types of auditory content for relaxation. The instrumental music and the combination form of music and natural soundscape gained high acceptance regarding subjective relaxation experience. Nature white noise might be more suitable for masking environmental noises for a focused state. The natural soundscapes and ambient music can evoke spatial imagery and enriched sensations by creating an acoustic environment or atmosphere. However, the preferences on nature sounds and ambient music vary widely from individual to individual and user experience evoked by the same soundscape, or ambient music shows a larger deviation. The combined form of instrumental music and nature sounds has a great potential as an auditory feedback in an interactive system for relaxation purpose. However, the nature sound should be selected carefully considering its complexity and target audience. The selected nature sounds need to be arranged into a musical form or composition. Only well-paired nature sounds and instruments could complement each other.

8. ACKNOWLEDGMENTS

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