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A Cross-modal Study on Scent and Music for Hospital Environment Design

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Scent and music are prevalently applied on various occasions to create an affirmative environment, lowering people's anxiety level, or enhancing buying behaviors. However, hardly has the simultaneous implementation of scent and music in hospital environment been determined. Towards a better understanding about the olfactory and auditory environment in hospital condition, therefore, we investigated the effects of scent and music on people's mood and stress in wards. We conducted an experiment with 3 groups of scent (peppermint, rose geranium, and control) and 2 pieces of healing music. As a result, our study revealed that compared to scent, music had much weaker effects on people's stress evaluation, but significantly affected mood. On the other hand, scent noticeably affected both mood and stress evaluation. These implications definitely enhanced our comprehension of the use of scent and music, and we also obtained further inspiration for the design of scent and music environment in wards.

Keywords: scent; music; hospitalization; mood; stress

1   Introduction

Ambient environmental stimuli are believed to affect people's mood, cognition, and behaviour (Fenko and Loock, 2014). In addition, the common belief that though people perceive discrete stimulus, their emotional response is determined based on the whole configuration of stimuli is widely convinced (e.g., Holahan,1982). That means, mental images are usually created by combining olfactory, auditory, and other sensory inputs. The congruent combination of scent and music in terms of arousal is reported to significantly raise consumers' satisfaction of the retail store, and bring about impulse buying (Mattilaa and Wirtz, 2001).

On medical occasion, where physical medical treatment is definitely required, psychological medication is also indispensable. Research showed both music and scent could reduce patient's anxiety in a waiting room of a plastic surgeon, while the combination of scent and music was not effective (Fenko and Loock, 2014). Similar studies like Cepeda et al. verified that music diminished pain intensity levels and opioid requirements (2006), and music therapy is reported to be an attractive and successful method for palliative care (Ichie, 2006). The role of props and music were explored in dementia care to engage participants and inform design (Morrissey et al., 2016).

On the other hand, the scent of orange sweet is clarified to have positive effect on a sound sleep, and refreshes wakeup of aged females (Matsunaga et al., 2013). However, little observation is found about using of scent and music simultaneously.

According to a review article summarizing the present state of aromatherapy research in nursing (Suzuki and Okubo, 2008), although the number of papers has increased, few of them are evident. Furthermore, blood pressure and pulse rate are also suggested not effective to examine the effect of aromatherapy, while the measurement of autonomic nervous activity is recommended to investigate subtle physical changes by aromatherapy. Therefore, we are notably inspired to employ other methods, such as Kansei subjective evaluation to observe the effect of scent. Also, we cannot ignore the intriguing issue that although relaxing music is usually involved during aromatherapy in practical condition, the effect of aromatherapy was examined without music in experimental environment.

In hospital room, patients tend to feel more stress due to the unfamiliar, too well-organized living environment which would interfere health recovery (Kawaguchi et al., 1994). Daemen clarified that the hospital room could be seen as the epicenter of patient experience design, because they spend most of their time there. Prior research on healing environment design has identified essential design characteristics (Schreuder, Lebesque, and Bottenheft, 2016). A broad range of mood-regulating activities is convinced to best influence mood (Desmet, 2015). Thus, to refine ward environment, and lead to patients' well-being, in this research, we investigated the relationship between scent and music, by exploring how scent and music in different arousal affect people's mood and stress in wards. The fundamental knowledge generated from this research will contribute to novel hospital environment design and improve the hospitalization experience for affected patients. Such understanding is particularly essential as the problem of aging society is becoming inevitably severer progressively (Ejiri et al., 2018).

2   Preliminary Experiment

The purpose of preliminary experiment is to decide proper scent and music stimuli. As clarified in previous research (Zhou and Yamanaka, 2018), peppermint and rose geranium were perceived pleasant, but high arousal and low arousal respectively. Therefore, we used these 2 kinds of scent in this study as well. For music, we chose a healing music album called <Aroma> by Makiko Hirohashi, which is relatively relaxing, soothing, and is recommended to be applied during aromatherapy, and massage by aroma therapists. We selected 2 pieces of music as high arousal music stimuli *(<Orange - Refresh>* and *<Rosemary - Concentration>*), and 2 pieces of music as low arousal stimuli *(<Sandalwood - Meditation> and <Lavender - Fall asleep>*). We expected to determine a high arousal music, and a low arousal music by this experiment. Because all music in this album is comparatively relaxing, to let participants get used to the music atmosphere, we applied another piece of music *(<Frankincense - Balance>*) to play at the beginning as baseline.

2.1   Procedure

During the experiment, firstly, the participant was asked to listen to the baseline music *(<Frankincense - Balance>*) for 1 minute, and answer the questionnaire to rate how pleasant and how arousing it was. Then, we randomly played another music for 1 minute, and let the participant fill the same questionnaire. The same procedure was repeated until all 5 music were tested.

10 participants (2 males, 8 females; age: 26.6± 4.34) took part in this experiment. The content of the questionnaire is a two-dimension mood scale to measure psychological arousal level and hedonic tone (Sakairi et al., 2003), including 8 adjectives (energetic, motivated, frustrated, on edge, relaxed, calm, inactive, and sluggish). We also added a question at the beginning to verify whether the music stimulus is long. Participants rated each item with a 9-point Likert scale, from "not at all" to "very much". Friedman test was performed on 4 music stimuli, as well as Wilcoxon pair-wise comparison as Post hoc tests.

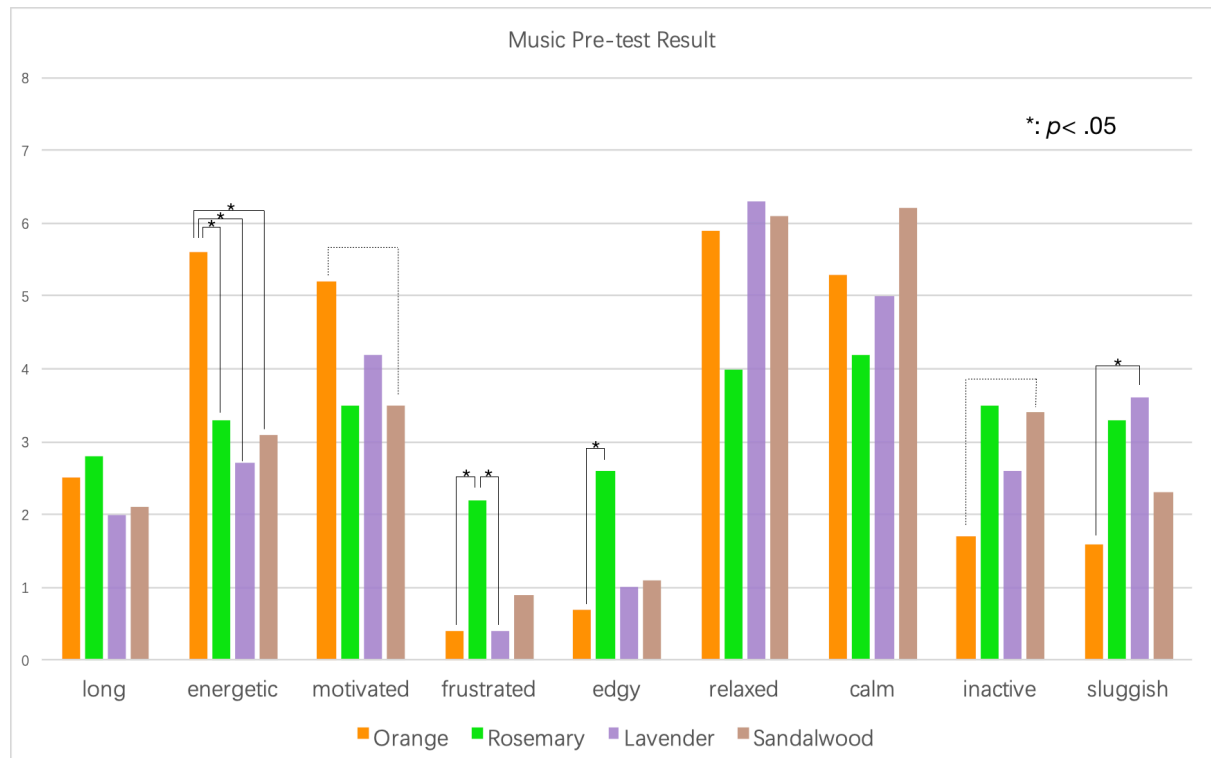## 2.2   Result

Figure 1. Result of Music Preliminary Experiment

From Figure 1, we can know that *<Rosemary - Concentration>* was evaluated significantly higher than *<Orange - Refresh>* ($p= .047$) and *<Lavender - Fall asleep>* ($p= .047$) on "frustrated", and it was also considered significantly "edgier" than *<Orange - Refresh>* ($p= .041$). In addition, *<Orange - Refresh>* was shown to be more "energetic" than the other 4 music ($p< .05$), we chose *<Orange - Refresh>* as the high arousal music stimulus consequently. The results also showed that <Sandalwood - Meditation> was evaluated both higher than *<Orange - Refresh>* on "relaxed" and "calm", which was different from *<Lavender - Fall asleep>*. Moreover, the substantial difference between *<Sandalwood - Meditation>* and *<Orange - Refresh>* on "motivated" and "inactive" was seen. Accordingly, *<Sandalwood - Meditation>* was selected as the low arousal music stimulus.

2.3   Summary
As yielded by the results, we considered to apply *<Orange - Refresh>* as the high arousal music stimulus, and *<Sandalwood - Meditation>* as the low arousal music stimulus in further experiment. Because some participants reported that listening to the music for only 1 minute

destroyed the sense of unity, as we also confirmed that participants did not reckon the music stimuli long, we played the entire music (around 8.5 minutes) in the main experiment.

3   Main Experiment

In this experiment, we manipulated 2 music stimuli, and 3 scent groups (peppermint, rose geranium, and control). In the control group, we employed alcohol instead of water to avoid drastic change of humidity of the experiment environment. Each scent was presented by essential oil, and the essential oil bottle was installed in an aroma diffuser, which periodically spreads out scent for 10 seconds, and rests for 50 seconds. Music stimuli was demonstrated by a MacBook (at around 77dB) in the same way as preliminary experiment.

3.1   Procedure

This experiment was conducted in a room which was arranged like a ward, shown in Figure 2. Each participant was presented with 1 combination randomly chosen from the total 6 combinations of scent and music.

Figure 2. The Environment of Main Experiment

After informing the instructions about the experiment, participants were indicated to sit and relax on the bed as staying in hospital. Subsequently, the curtain was closed, a music stimulus was played and the aroma diffuser was turned on at the same time. As soon as the music ended, the diffuser was turned off. After that, the participant was asked to answer a questionnaire to report his/her mood and stress level. After each experiment, we ventilated the room until it was scentless.

5 participants took part in each combination of scent and music, except 3 people in the group of rose geranium with low arousal music. In total, there were 28 participants (11 males, 17 females; age: 25.2± 4.14), and all of them are healthy students from the university. After the experiment, we asked people in control group whether they felt any scent, and none of them recognized the smell of alcohol.

The questionnaire included the assessment on mood and stress level. The mood scale is developed to examine patients' as well as common adults' mood condition on clinical occasion (Sakano et al., 1994). There are 40 items divided into 5 factors to describe mood

state: tension and excitement, refreshing mood, fatigue, depressive mood, and anxious mood. Participants assessed their mood by a 4-point Likert scale, from "1: not at all" to "4: very much". Besides mood evaluation, participants also rated their stress level under 38 situations during hospitalization. This scale was revised by Kawaguchi et al. (1994) based on another prior research (Volicer and Bohannon, 1975) to observe the stress degree of inpatients. Participants reported their stress level in the same way as mood assessment, from "1: not at all" to "4: very much".

3.2   Result

We performed MANOVA on mood assessment, and stress evaluation individually after transforming the original nonparametric data to rank (Conover and Iman, 1981). According to the result of Multivariate tests, there was a statistically significant difference in mood assessment based on scent (F (42, 4) =12.03, p = .013; Wilk's Λ = .00). To state specifically, rose geranium significantly raised up the feeling of "too filled with emotions to stand still" than peppermint and control group (both p= .033). Moreover, rose geranium also had significant difference on "painful" (F (2, 22) =6.81, p= .005), with peppermint (p= .026). In the aspect of music, it was indicated that low arousal music evoked stronger mood on "troublesome" (F (1, 22) =5.02, p = .036), "painful" (F (1, 22) =8.85, p = .007), and "lots of (negative) memories come across my mind" (F (1, 22) =9.81, p = .005) than high arousal music. However, high arousal music was verified to trigger the mood of "lonely" more easily than low arousal music (F (1, 22) =5.08, p = .034). Furthermore, the significant effect of the interaction of music and scent was also demonstrated by Multivariate tests (F (42, 4) =8.42, p = .025; Wilk's Λ = .00). In addition to the mood which was generally influenced by scent or music, such as "troublesome" (F (5, 22) =2.76, p = .044), "painful" (F (5, 22) =6.38, p = .001), and "lonely" (F (5, 22) =3.14, p = .028), the specific combination of scent and music also had significant effects on the mood of "apathetic" (F (2, 22) =13.06, p = .000), "depressed" (F (2, 22) =6.54, p = .006), and "vain" (F (2, 22) =12.18, p = .000). As claimed by Post hoc tests, the combination of LR (Low arousal music and Rose geranium) received significantly higher score than HC (High arousal music and Control, p = .029), HR (High arousal music and Rose geranium, p = .029), and LP (Low arousal music and Peppermint, p = .006) on "apathetic". Similarly, it was revealed that the combination of LR definitely generated the feeling of "depressed" compared with LP (p = .019), and was also higher scored on "vain" than HR (p = .007), LC (Low arousal music and Control, p = .036), and LP (p = .007).

On the other hand, music did not show significant effect on stress according to the result of Multivariate tests, while the significant difference by scent was confirmed (F (42, 4) =9.87, p = .019; Wilk's Λ = .00). With the scent of peppermint, participants significantly felt less stress when they "not knowing when to expect things will be done to you" than rose geranium (p= .020), and control group (p= .023). Under the situation of "having to be assisted with bathing", peppermint also appeared significantly positive influence than control group (p= .045). We also observed that compared with control group, rose geranium considerably lessened the stress of "having to be assisted with a bedpan" (p= .016). Further, Multivariate tests yielded a notable result in stress evaluation based on the combination of scent and music. Therefore, we realized that LP significantly reduced the stress level in the situation of "having nurses or doctors talk too fast or use words you can't understand" (F (5, 22) =3.40, p = .020). Specifically, the combination of LP was enormously rated less stressful than HP (High arousal music and Peppermint, p = .034), and LR (p = .028).

4 Discussion

As well as other interior design elements such as colors, music and scent are also pretty effective in providing an improved user experience in ward. Our findings emphasized that both music and scent could affect the mood of people in a ward, but stress seemed to be more affected by scent. This suggests that although we discuss using music or scent as design aspects to reduce negative moods and stress in the same situation, designers should notice that negative moods and stress are different things and could be dealt with different treatments. Scents could be applied to particularly reduce the stress level, and music could be used focusing on the mood improvement in a ward or rehab room.

In education program for patients, pleasant aromatherapy and relaxing music are regarded as relaxation techniques to calm down, alleviating the stress caused by pain and side effects of medicine (Yamada et al., 2003). Unexpectedly, our results implied that low arousal stimuli intensified despondent and worried mood. As substantiated in a prior study, scent modifies people's perception of music, and low arousal scent has the potential impact on lowering the arousal level of music (Zhou and Yamanaka, 2018). Therefore, a conceivable hypothesis might be that low arousal scent (rose geranium) considerably diminished the arousal level of music, so that the low arousal combination might lead to an overly low arousal state, such as melancholic and gloomy moods, far beyond relaxing and calm moods.

An intriguing finding is that despite high arousal music reduced most of the negative moods, "loneliness" was only allayed by low arousal music. The difference between "loneliness" and other negative moods such as depression should be further discussed in the subsequet study. Nevertheless, designers should be aware of this exception that when targeting on "loneliness", low arousal music seemed to be a better choice than high arousal one. Still, the reason for high arousal music boosts "lonely" feeling is undetermined on the authority of existing studies, further observations are needed to explore the effect of high arousal music.

When it comes to the stress of bathing and excreting in ward, it is manifested that different types of scent should be considered. Peppermint lowered participant's stress level of having to take bath inconveniently, and rose geranium reduced the stress of having to be assisted with a bedpan. It is believed that floral scent might be better for covering unpleasant smell since it is widely used and popular for toilet, and mint is preferable for giving users the feeling of refreshing and clean.

5 Conclusion

In summary, our work revealed that music and scent could influence people's experience in different ways, with music relatively tends to affect mood more than stress, and scent tends to affect both. Moreover, we are enlightened that when applying together, low arousal music and low arousal scent might not provide a relaxing, peaceful experience as expectation. Other combinations such as low arousal music and high arousal scent might be further beneficial to inpatients, because the upsurge of tension brings about cheer and confidence to them, which will be absolutely advantageous to their health recovery. It is indubitable that the new knowledge and perspectives gained through this work will provide designers with the critical information to execute needed design techniques, ultimately upgrading the welfare for patients. Our findings of this exploratory study will also serve to the thorough and supplementary research in the future.

Although we tried to re-create a ward environment for the experiment, the participants in our study were not real-life patients. Therefore, we look forward to improving our theory and method and conduct experiments in a real hospital in the near future.

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