Effects of relaxation programs with music on human immune function and mood

Kayoko Urakawa[1], Akiko Okawa[2]

Abstract

We investigated the effect of relaxation on immune function in healthy university students who underwent a stress management relaxation program that combined physical and mental activation with the calming effect of meditation. Changes in immune response were determined by measuring concentrations of secretory immunoglobulin A (S-IgA) and cortisol. Mood changes were assessed by Profile of Mood States (POMS).

Music was added to the relaxation program in one group to evaluate the effect of music on immune response. The relationship between immune response and changes in emotions and mood was also studied. After completion of the relaxation program, there was a significant increase in S-IgA concentration but no change in cortisol concentration, indicating a transient immune response. Negative mood was significantly improved by the program. These findings suggest that the mixed relaxation program used in this study is effective for managing stress. Significant correlation between changes in cortisol concentrations and Vigor scores of POMS, suggesting that it would be morderate stimulation of the autonomic nervous system by mental activation on the program.

Key Words: Secretory immunoglobulin A, cortisol, relaxation, stress management, music

Introduction

Secretory immunoglobulin A (S-IgA) is a humoral immune antibody with a surface membrane that allows it to be active in mucus. Because large amounts of S-IgA are found in the saliva and initial breast milk, S-IgA is thought to be the first line of biological defense against bacteria and viruses, which might enter through the oral cavity. The results of a study by Kugler *et al*. (1996) suggest that stimulation of nonspecific humoral immune function by acute psychological stress, such as tension or excitement, leads to a rise in concentrations of S-IgA and cortisol.[1] Other studies have also reported increases in S-IgA concentration in response to positive mood changes produced by watching humorous films,[2] changes in feelings of pleasure and guilt,[3] and both positive and negative moods.[4]

In contrast, S-IgA concentration falls in response to chronic stress in students undergoing examinations.[5] Deinzer *et al*. (2000) found that S-IgA concentrations in students remained low for two weeks after their examinations had finished.[6] Irwin *et al*. (1987) reported that natural killer cell activity is impaired during bereavement.[7] Furthermore, long-term suppression of biological defense function is known to increase the risk of disease and may lead to stress-related physical disorders, including gastrointestinal, cardiovascular and autoimmune disorders, as well as allergies and cancer. Prolonged stress-induced mental fatigue reduces the ability to deal with interpersonal relationships and impairs concentration, thus increasing the likelihood of maladjusted behavior, depression, and neurosis.

1 School of Nursing, Faculty of Medicine, Mie University,
Edobashi 2-174, Tsu city, Mie Pre. Japan
Email: adiemus@nurse.medic.mie-u.ac.jp Tel/Fax: 059-231-5233
2 Nagoya City University School of Nursing

Managing stress in order to reduce the response that leads to symptoms and disease may be effective for restoring, maintaining and promoting health. Most stress management techniques aim to restore homeostasis through physical and mental relaxation. The methods used include breathing techniques, progressive muscle relaxation, exercise, autogenic training, image therapy, music therapy, aromatherapy, meditation, individual psychotherapy (e.g., cognitive therapy), and group therapy. A meta-analysis by Berger *et al*. (1997) suggests that stress management interventions have a small but positive impact on the immune system.[8] Another study reported that following relaxation using visualization and massage, a rise in S-IgA concentration was observed and no change in the concentration of the stress indicator cortisol was detected.[9] Results showing that a positive emotional state and listening to certain types of music result in an increase in S-IgA concentration also indicate that music has a beneficial effect on immune function.[10] Numerous clinical studies have used music to alleviate pain and anxiety.[12] Music produces an immediate effect on a person's psychological state by diverting attention from stressors to a positive stimulus (i.e., music) and eliciting emotions associated with past experiences.[11]

Relaxation techniques were introduced in Japan in 1961, and the first Japanese study of the use of relaxation in the field of nursing was published in 1982. Growing interest in stress and health in the 1990s prompted more research on music- and aroma-based relaxation techniques. However, the literature contains fewer than ten studies on stress management using relaxation programs that combine more than one technique. Japanese studies to date have also neglected to investigate the effects of relaxation programs using indicators of immune function.

We therefore devised our own original relaxation program that combined reduction of muscle tension with a meditation-induced state of calm, and investigated the effects of this program on the body's immune response using salivary S-IgA and cortisol concentrations[13]. In the present study, we examine the relationship between psychological changes and immune response by measuring changes in mood and emotions using the Profile of Mood States (POMS). Music is also added to the relaxation program for one group (the music group) but not the other group (the control group) to test the hypothesis that the addition of music to relaxation programs enhances relaxation effects.

Methods

Subjects

The subjects were 40 healthy female university students (mean age, 20.1 years; range, 19-22 years) who consented to participate in the study after being informed of the content of the relaxation program. The subjects were randomly divided into two groups consisting of a music group and a non-music group (20 subjects/group). The relaxation program was carried out in October 2001 (on 2 days) and was performed after lunch (13:00-14:30) in both groups.

Procedure

Before the relaxation program was started, the subjects were taught about abdominal breathing (5 minutes) in preparation for meditation. The program was then carried out in the following four steps over a total of 40 minutes: (1) alternately tensing and relaxing the arms and face repeatedly (5 minutes); (2) gentle exercise to stimulate the muscles of the entire body (5 minutes); (3) massage of the arms and head by another person (10 minutes); and (4) meditation in a reclining chair (20 minutes). The music used was Healing Time (Fumio Miyashita) in (1), Dreams (The Cranberries) in (2), The Water Is Wide (Sissel featuring Zamfir, Trad., arranged by Akira Senju) in (3), and Refresh Time (Fumio Miyashita) in (4). The researchers selected the music based on the content of each step of the relaxation program. Relaxing music with a slow tempo and no lyrics was used in steps (1), (3), and (4), and lively music that was easy to move to was selected for step (2). The music was played from stereo speakers (CA7 System Component, Panasonic). The subjects wore clothes and footwear that were comfortable to move in. The instructor was one of the researchers. The relaxation program was carried out in a quiet room that was large enough for approximately 40 people to move around freely. The temperature of the room was set at 21℃ and the lights were

Table 1. Effects of relaxation program on S-IgA, cortisol and POMS scores in music and non-music groups[a)]

	Music group[b)]		Non-music group[b)]		Effects (F-Values)		
	Before	After	Before	After	Program	Music	Interaction
S-IgA (μg/ml)	77.34(38.6)	170.2(78.9)	80.4(47.7)	161.9(71.3)	38.19***	0.04	0.16
Cortisol (ng/ml)	5.4 (2.7)	6.5(2.7)	4.8(3.1)	5.6(2.9)	2.09	1.11	0.06
POMS (T-score) Tension-Anxiety	54.1 (9.5)	44.8(8.8)	51.6(9.0)	41.5(7.6)	24.44***	2.23	0.05
Depression-Dejection	57.0 (8.9)	48.9(6.9)	55.7(13.2)	47.8(9.0)	13.40***	0.30	0.00
Anger-Hostility	52.1 (8.2)	43.8(6.0)	49.8(11.4)	42.8(7.9)	15.74***	0.72	0.11
Vigor	50.9 (10.3)	54.0(9.4)	49.1(11.1)	47.4(8.1)	0.1	3.71	1.22
Fatigue	52.7 (7.8)	46.5(7.6)	50.4(11.2)	44.2(8.3)	9.86**	1.36	0.00
Confusion	59.2 (9.5)	51.1(7.5)	55.5(10.1)	48.2(9.8)	13.68***	2.49	0.03

a) Two-way analysis of variance with program (before vs after) and music (with vs without) as factors
b) Average with standard deviation in parenthesis. *p<0.05; **p<0.01; ***p<0.001

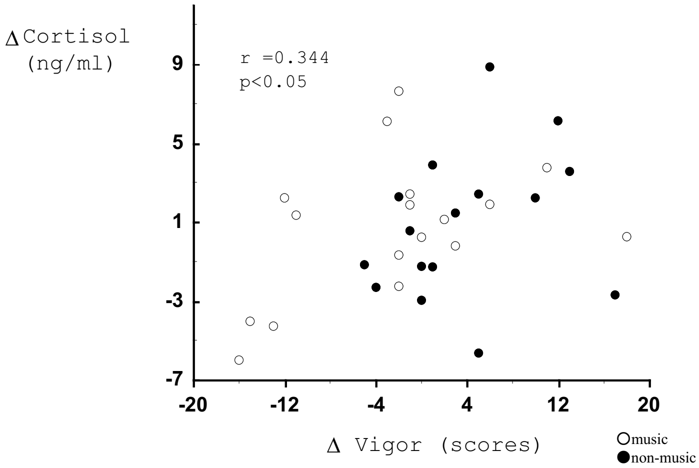

Fig 1. Correlation between changes in cortisol and Vigor scores in 33 female students.

turned off before meditation, which was carried out in natural light only.

Both pre- and post-program, subjects were required to complete the Profile of Mood States (Japanese edition, 1994), and saliva was collected for 2 minutes by Salivette (SARSTEDT, Aktiengesellschaft & Co. D-51588 Nümbrecht, Germany); venous blood samples were also collected. After collection, the samples were immediately centrifuged and stored at -20℃ until analysis. S-IgA concentration was measured by SRL. Cortisol concentration was measured by the researchers using high performance liquid chromatography. We were able to measure cortisol concentration in 33 of the 40 subjects (music group n=17, non-music group n=16), because 7 samples were too small for analysis.

Results

Table. 1 shows the mean ± SD of S-IgA and cortisol concentrations and POMS scores. Two-way analysis of variance revealed that S-IgA concentration was significantly increased and all negative mood was significantly improved by the program. Significant correlation was seen between changes in cortisol concentrations and Vgor scores in all subjects combined (Figure 1).

Discussion

We used a mixed relaxation program that combined reduction of muscle tension through physical movement with a state of calm induced by meditation in order to achieve both mental and physical relaxation. The results showed a significant rise in S-IgA concentration post-program in both the music group and the non-music group. In contrast, no statistically significant change was observed in cortisol concentration in either group.

Evidence suggesting that S-IgA concentration rises in response to acute psychophysiological arousal has been reported.[1] The changes in S-IgA concentration seen in our study may have been partially due to physiological activity because movement to stimulate the muscles of the whole body in steps (1) and (2) during the first 10 minutes of the relaxation program would have improved blood circulation by stimulating the autonomic nervous system. The positive psychological effect of participating in an enjoyable activity is also likely to have contributed to the rise because previous studies have shown that S-IgA concentration increases as a result of the positive mood changes produced by watching humorous films[2], and by listening to music.[4] The relationship between S-IgA and the POMS score is discussed later.

Our experience showed that participants laughed during various movements and that physical expression using one's imagination (e.g., pretending to be a bird flapping its wings or a fish swimming through the sea) seemed to encourage more laughter and enjoyment among participants than simple mechanical movement. This laughter and enjoyment likely resulted in greater psychophysiological activation. Relaxation programs are therefore more effective if they are made more enjoyable by adopting a flexible approach so that movements to stimulate the entire body can be changed based on the reactions of the participants and by tailoring the program to the characteristics of the participants (e.g., age, sex, and health status). Green *et al*. (1987) reported a rise in S-IgA concentration and no change in cortisol concentration or mood after visualization and massage in a group session conducted as part of a 20-minute relaxation program.[9] Groer *et al*. (1994) observed an increase in S-IgA concentration after nursing back rubs.[14] These reports indicate that the massage in step (3) of our program produced both mental and physical relaxation by promoting blood flow and reducing muscle tension.

Because our subjects had no previous meditation experience, breathing techniques were taught before the relaxation program and were subsequently used in the meditation component. Diaphragmatic breathing reduces sympathetic nervous system arousal and is the method most commonly used to deal with general stress. Meditation relaxes both the mind and body due to physiological changes resulting from decreased sympathetic nervous system activity, such as a decrease in heart rate, respiration rate, blood pressure and oxygen consumption, an increase in cutaneous blood flow, and the appearance of alpha waves. Psychological changes, such as alleviation of anxiety, also aid relaxation.

Based on the above observations and the fact that there was no statistically significant change in cortisol concentration, the rise in S-IgA concentration in our subjects after the relaxation program appeared to be a transient immune response resulting from a decrease in physical and mental tension. Numerous studies have confirmed that cortisol concentration rises in response to stress.[15] Cruess *et al*. (2000) observed a decrease in cortisol levels in HIV-seropositive men after short-term 45-minute relaxation exercises conducted as a part of cognitive-behavioral stress management intervention sessions. This observation suggests that the relaxation exercises had an impact on hypothalamic-pituitary-adrenal (HPA) axis function and that cortisol could be used as a neuroendocrine marker for short-term changes in mood.[16] In our subjects, no change in cortisol concentration was seen at completion of the relaxation program, indicating the absence of a stress response. The difference between our results and the findings of Cruess *et al*. was probably due to the effects of physical stimulation used in our program, differences in age and health status of the subjects, and HPA axis responsiveness.

Examination of the relationship between S-IgA or cortisol concentrations and changes in mood and emotions based on the POMS revealed a significant change in the POMS T-score after the relaxation program. This suggests that psychological activation was partly responsible for the rise in the S-IgA concentration, as discussed earlier. However, no significant correlation was shown between changes in POMS T-score and changes in S-IgA concentrations because intervention was transient. After completion of this program, no effect of music on cortisol concentration, but significant correlation was seen between changes in cortisol concentrations and POMS scores (Vigor). These findings suggest that it would be moderate stimulation of the autonomic nervous system by mental activation on the program. Jemmott *et al*. (1987) found that students with appropriate social support had high S-IgA concentrations,[5] and a study of the relationship between explanatory style and S-IgA concentration by Brennan *et al*. (2000) showed negative correlations between S-IgA and pessimism and hopelessness scores.[17] The relationship between change in mood and immune response therefore needs to be verified by first determining the level of psychological stress and the characteristics of such stress in relaxation program participants.

We hypothesized that adding music to relaxation programs promotes relaxation because numerous studies have obtained generally positive results that indicate music decreases sympathetic nervous system activity, which reduces heart rate and blood pressure, reduces anxiety, and improves mood.[18] In all four steps of our relaxation program, we used music that corresponded to the particular movements in each step. However, we found no relationship between the inclusion of music and change in concentration of S-IgA or cortisol after the program. Other researchers have found that listening to music results in a rise in cortisol levels,[19,20] and another study reported that the salivary S-IgA concentration increased in patients awaiting surgery who listened to preferred music for 60 minutes.[21] Davis *et al*. (1989) stated that the autonomic nervous system and muscle activity were stimulated when preferred music reduced anxiety and induced a relaxed state.[22] Many studies therefore suggest that listening to preferred music is more effective for achieving a sense of calm and change of mood. We did not take into consideration the personal tastes of the subjects when selecting the music used in our relaxation program. Elements in our program other than music (i.e., breathing, exercise, muscle relaxation, massage, and meditation) may have also had physiological effects, and thus no significant relationship was seen between the inclusion of music and changes in S-IgA and cortisol concentrations after completion of the program. However, we intend to conduct further research on the effects of music because music resulted in a change in mood and emotions on the POMS.

To date, research has not explained the mechanism by which music affects the body. However, the factors that play a role in physiological and psychological responses to music are complex. For example, one study (2001) suggests that the extent to which music reduces psychological stress differs depending on an individual's stress copying style.[23] Further work is needed to elucidate why the physiological and psychological effects of music vary depending on individual characteristics and type of music.

In summary, we observed a significant rise in S-IgA concentration but no change in cortisol concentration in individuals who underwent a relaxation program combining physical and mental activation achieved by moderate stimulation of the autonomic nervous system with a state of calm induced by meditation. Our findings suggest that relaxation produces an immune response and is therefore effective for managing stress. Since these changes were a transient response due to intervention, further study investigating long-term intervention will be needed in order to determine whether relaxation promotes immune function. The following controls were required when carrying out the present study. Because S-IgA and cortisol follow a circadian rhythm[24] and differences in responsiveness also arise depending on the indicator used (e.g., immune cells, hormones, antibodies), data must be obtained at a set time to further increase accuracy. Furthermore, factors other than intervention must be controlled to evaluate efficacy because the immune response is also affected by variables such as drug, alcohol, caffeine, and nicotine intake. We controlled the time that S-IgA and cortisol were measured, but the study was limited by the fact that we were unable to assess physical factors in the subjects before the relaxation program. Individual emotional and cognitive style, stress coping style, and response to stress are also important factors that need to be taken into account when investigating effect on immunity. Therefore, data in further studies need to be collected with these factors and conditions carefully controlled.

Further research on the immune system and more detailed investigation of the efficacy of stress management programs such as the one used here will enable the development of programs that have an even greater positive impact on immune function. Such programs are likely to reduce the risk of infection, help prevent complications of chronic disease, as well as restore, maintain, and promote health during stressful periods, particularly in individuals who are depressed or prone to stress. We were unable to verify the effects of music in the present study. Our next task is to devise effective "immunity training programs" by investigating methods of incorporating preferred music into such programs and providing concurrent psychological support.

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REFERENCES

1. Kugler J, Reintjes F, Tewes V, Schedlowski M. Competition stress in soccer coaches increases salivary immnoglobulin A and salivary control cortisol concentrations. *Journal of Sports Medicine and Physical Fitness 1996;* **36**: 117-20.
2. McClelland DC, Cheriff AD. The immunoenhancing effects of humor on secretory IgA and resistance to respiratory infections. *Psychology and Health 1997;* **12**: 329-44.
3. Lowe G, Greenman J. Pleasure, guilt and secretory immunoglobulin A. *Psychological Reports 1999;* **85**: 339-340.
4. Hucklebridge F, Lambert S, Clow A, Warburton DM, Evans PD, Sherwood N. Modulation of secretory immunoglobulin A in saliva; response to manipulation of mood. *Biological Psychology 2000;* **53**: 25-35.
5. Jemmott JB 3rd, Magloire K. Academic stress, social support, and secretory immunoglobulin A. *Journal of Personality and Social Psychology 1988;* **55**: 803-810.
6. Deinzer R, Kleineidam C. *et al*. Prolonged reduction of salivary immunoglobulinA (sIgA). *International J of Psychophysiology 2000;* **37**: 219-32.
7. Irwin M, Daniels M, Smith TL, Bloom E, Weiner H. Impaired natural killer cell activity during bereavement. *Brain, Behavior, and Immunity 1987b;* **1**: 98-104.
8. Berger JA, and O'Brien WH. The effects of cognitive-behavioral stress management interventions on immune function: A meta-analytic review. *Manuscript in preparation, Bowling Green State University 1997*, Bowling Green, OH.
9. Green RG, Green ML. Relaxation increases salivary immunoglobulin A. *Psychological reports 1987;* **61**: 623-629.
10. McCraty R, Atkinson M, Rein G, Watkins AD. Music enhances the effect of positive emotional states on salivary IgA. *Stress Medicine 1996;* **12**: 167-175.
11. White JM. State of the science of Music Interventions: Critical Care and Perioperative Practice. *Critical care nursing clinics of North America 2000;* **12**: 219-225.
12. Biley Francis C. The effects on patient well-being of music listening as a nursing intervention: a review of the literature. *Journal of clinical nursing 2000;* **9**: 668-677.
13. Urakawa K, Yokoyama K. Can relaxation programs with music enhance human immune function?. *The Journal of alternative and complementary medicine 2004;* **10**: 597-598.
14. Groer M., *et al*. Measures of Salivary Secretory Immunoglobulin A and State Anxiety After a Nursing Back rub. *Applied nursing research 1994;* **7**: 2-6.
15. Cohen S, Miller GE, Rabin BS. Psychological stress and antibody response to immunization: a critical review of the human literature. *Psychosomatic Medicine 2001;* **63**: 7-18.
16. Cruess DG, *et al*. Reductions in salivary cortisol are associated with mood improvement during relaxation training among HIV-seropositive men. *Journal of Behavioral Medicine 2000;* **23**:107-122.
17. Brennan FX, Charnetski CJ. Explanatory style and immunoglobulin A (IgA). *Inergrative physiological and behavioral science 2000;* **35**: 251-255.
18. Snyder M, Chlan L. Music therapy. *Annual Review of Nursing Research 1999;* **17**: 3-25.
19. Goff LC, Pratt RR, Madrigal JL. Music listening and S-IgA levels in patients undergoing a dental procedure. *International journal of arts medicine 1997;* **5**: 22-26.
20. Charnetski CJ, Brennan FX. Effect of music and auditory stimuli on secretory immunoglobulin A (IgA). *Perceptual and motor skills 1998;* **87**: 1163-1170.
21. Miluk-Kolasa B, Obminski Z, Stupicki R, Golec L. Effects of music treatment on salivary cortisol in patients

exposed to pre-surgical stress. *Experimental and Clinical Endocrinology 1994;* **102**: 118-120.

22. Davis WB, Thaut MH. The Influence of preferred relaxation music on measure of state anxiety, relaxation, and physiological. *Journal of Music Therapy 1989;* **26**: 168-187.
23. Urakawa K, Sato M. Study of the different effect of the BGM depending on the stress coping type. *The Journal of Japanese Music Therapy Association 2001;* **2**: 155-160.
24. Hucklebridge F, Clow A, Evans P. The relationship between salivary secretory immunoglobulin A and cortisol: neuroendocrine response to awakening and the diurnal cycle. *International Journal of Psychophysiology 1998;* **31**: 69-76.