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The Effects of Active and Passive Participation in Musical Activity on the Immune System as Measured by Salivary Immunoglobulin A (SIgA)

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The purposes of this study were (a) to determine if musical activity would produce a significant change in the immune system as measured by Salivary Immunoglobulin A (SIgA), and (b) to determine if active participation in musical activity had a significantly different effect on the immune system than passive participation. Thirty-three participants (28 women and 5 men) were randomly assigned to one of 3 groups, 2 experimental and 1 control. Active group participants participated in a 30-minute session where they played various percussive instruments and sang. Passive group participants listened to 30 minutes worth of live music. Saliva samples were taken before and after sessions and SIgA concentrations were determined using radial immunodiffusion technique. All groups were found to be significantly different from each other. SIgA levels of the active group showed a significantly greater increase than those of the passive group and the control group, suggesting that active participation in musical activity produces a greater effect on the immune system than passive participation.

Throughout history, music has been used in conjunction with, as well as in place of, modern medicine as a form of healing. Observations supporting the use of music to treat physical diseases have been traced as far back as primitive tribal cultures (Taylor, 1997). Music elicits intense emotional and psychological responses in humans, providing distraction, motivation, mood elevation, and relaxation, as well as a means of prayer and reaching altered states of consciousness (Harvey, 1991). Matsuhashi et al. (1998) found that some bacteria cells produce and also respond to sound waves, possibly serving as form of intercellular communication. Music is comprised of various sound waves, along with many other factors, so one might wonder if music affects the listener on a physiological or cellular level. Although the physiological appeal of music is acknowledged, most applications of music have targeted psychological factors (Taylor, 1997).

During the first half of the 20th century and through the emergence of the National Association for Music Therapy, physiological responses to music such as pulse rate, blood pressure, galvanic skin response, cardiac output, respiratory rate, and muscle tone were studied (Taylor, 1997). The relationship between music and medicine continues to be explored through research providing a better understanding of music's influence on human neurophysiological functions.

The psychological effects of music have been of a considerable interest recently, with reports that show music improves memory (Bolz, Schulkind, & Kantra, 1991), elevates mood (Lenton & Martin, 1991), increases attention span (Fox, 1971), and reduces stress (Spintge & Droh; 1992, Charnetski & Brennan, 1998). On account of the rich research that connects psychological factors to immune function (Bartlett, Kaufman, & Smeltekop, 1993; Borysenko, 1984; Avants, Margolin, & Salovey, 1991; Charnetski, Strand Jr., Olexa, Turoczi, & Rinehart, 1989; Deinzer & Schuller, 1998; Hucklebridge, Clow, & Evans, 1998; Kiecolt-Glaser & Glaser, 2000; Kuegler, Reintjes, Tewes, & Schedlowski, 1996; Leonard, 2000; McKarthy, Ouimet, & Daun, 1992; Taylor, 1997; Winzer, Ring, & Carrol, 1999), many researchers have gone a step further to investigate the possibility of music's influence on the immune system.

Diseases and other health problems are caused biologically by hereditary predisposition and/or environmental factors (Borysenko, 1984). Whether or not the hereditary or environmental factors actually bring about disease can be determined by emotional and psychological factors like stress and states of mind (Bartlett et al., 1993; Borysenko, 1984). Charnetski et al. (1989) noted substantial data linking personality traits, increased stress and failure of immune defense mechanisms to the onset of autoimmune disease, cancer, and infectious disease. Stress has a profound influence on the immune system and can be a predisposing factor to diseases associated with immunologic responses. Increased exposure to stressful situations increases the probability of developing physical disorders like infections, allergies, and even cancer (Borysenko, 1984). Studies on both animals and humans indicate that stress suppresses immune function (Bartlett et al., 1993).

One particular immune mechanism, humoral immunity, is managed by B-cells, which have immunoglobulins on their surfaces (Borysenko, 1984). This immune mechanism is responsible for the production and release of specific antibodies that fight against diseases. Secreted by mucosal cells, secretory IgA is the principle immunoglobulin isotype found in saliva and all other body secretions (Marcotte & Lavoie, 1998); therefore, SIgA is considered the first line of defense against pathogens that invade the upper respiratory tract (Kugler et al., 1996). Correlations have been found between chronic psychological stress and low levels of SigA (Kugler et al., 1996), and people with low levels of SIgA also report more severe episodes of upper respiratory tract infection, and secrete more epinephrine in their urine (Borysenko, 1984).

While stress cannot be completely eliminated, there are ways in which the perception of stress and ability to adapt to stressors can be altered. Music has been adapted as a form of stress management; Spintge and Droh (1992) use anxiolytic music, which reduces the stress response in the cardiovascular and endocrine systems (Taylor, 1997). SIgA, Interleukin-1, and Cortisol have been used to measure immune responses to music listening and imaging activities involving music (Bartlett et al., 1993; McCraty, Atkinson, Rein, & Watkins, 1996; Rider & Achterberg, 1989; Rider, Achterberg, Lawlis, Goven, Toledo, & Butler, 1990; Rider & Weldin, 1990; Tsao, 1989). SIgA increased in groups exposed to music alone and to music combined with imagery over control groups (Rider & Weldin, 1990). Music can also be designed to evoke the same effects that positive emotional states have on immunity (McCraty et al., 1996). Charnetski and Brennan (1998) found that Muzak also increased IgA levels. Music Therapy has been found to increase IgA levels in children at the Children's Hospital in Cleveland (Lane & Olness, 1991). The results of these studies provide further confirmation that the immune system can be enhanced by music and conscious thought (Tsao, 1989).

We learn from Halpern (1985) that music has a strong impact on a listener's emotions, but that that impact is not accurately predictable. Schullian and Schoen (1984) found that listener's reactions were dependent on specific elements in the music. In comparing major to minor modal music, Charnetski et al. (1989) found that music in the major mode significantly increased IgA levels also indicating that analyzing music's influence on IgA can be done objectively and systematically. Bailey (1983) found listeners to respond more favorably and reported greater tension release when listening to live music versus taped music in a study. In looking at the effect of music therapy treatment on the depressive symptoms in elderly people with dementia, Ashida (2000) found that depressive symptoms decrease as treatment progressed. Ashida (2000) also noticed that active participation levels increased and passive participation levels decreased as treatment progressed, implying that there may be a negative correlation between depressive symptoms and active involvement. Although some studies have included active music making in their music groups, very little research has analyzed the effects of music making versus music listening on the immune system.

The purpose of this study was to investigate the effect of actively participating in music making versus passively listening to live music on the production of SIgA. Hypotheses for this study were: (a) there will be a significantly greater increase in SIgA concentrations for the active group over the control group, (b) there will be a significantly greater increase in SIgA concentrations for passive group over the control group, and (c) there will be a significantly greater increase in SIgA concentrations for the active group over the passive group.

Materials and Methods

Participants

Thirty-three undergraduate students at Willamette University in Salem, Oregon (mean age = 20 years; 5 men, 28 women) volunteered to participate in the study. Participant selection was determined by the following parameters: (a) must not have a chronic disease affecting the immune system, (b) must not be pregnant, and (c) must not have eaten or drunk anything other than water 30 minutes prior to the study. Six participants had over one year of formal music training at the high school/college level. Participants provided written consent and were randomly assigned to one of three groups: active, passive, or control.

Procedure

Each group consisted of 5–6 participants at a time and ran for 30 minutes. The active groups ($n = 11$) consisted of a music making session facilitated by a music therapy student. Subjects participated in call and response drumming and singing activities as well as short improvisations on a pentatonic scale using tone bars and drums.

Passive group ($n = 11$) session participants listened to live musical selections performed by university music students on piano, flute, tuba, and voice. Participants in the control groups ($n = 11$) were allowed to move freely about the room, talk, or sit quietly for the session. They were not allowed to listen to music, hum, sing, tap rhythms, or discuss music.

Saliva Samples

Saliva samples were collected before and after each session. Participants were instructed to place a swab in their mouth for 2 minutes and not to swallow during that time. Swabs were then placed in sealed test tubes and frozen within an hour after sampling until analysis. Before analysis, samples were centrifuged for 2 minutes at 3,000 rpm so as to remove the saliva from the swabs.

SIgA was chosen for this study because it is easily accessible, being present in saliva, and has been demonstrated as an effective short-term measure of immunocompetence (Rider & Weldin, 1990). SIgA concentrations were determined by Radial Immunodiffusion assay, the original method used for the measurement of serum proteins. The Radial Immunodiffusion technique has been found to be both reliable and unbiased (Rider & Weldin, 1990). This procedure is based on the phenomenon of an antigen-antibody reaction in a gel medium forming a precipitin ring. Measured samples of equal volume (5 microliters) of the test saliva were delivered into a well cut into commercially available, pre-prepared plates (low-level IgA; Kent laboratories) containing a uniform layer of buffered agarose gel, which was impregnated with monospecific human IgA antibody. Two reference concentrations of IgA were placed in each plate to check for possible deterioration and/or other discrepancies. Plates were then incubated at room temperature for 20 hours, during which the antigen (IgA) in the saliva diffuses into the agar, and antigen antibody complexes are formed, which produce a precipitin ring. The area within the precipitin

TABLE 1

Before and After Precipitin Diameters (mm) of the Three Groups.

	Active group		Passive group		Control group	
Subject	Before	After	Before	After	Before	After
1.	5	7.9	4.2	4.6	2.9	2.9
2.	5	5.9	2.9	3	6.3	6.4
3.	5.2	6.1	2.9	2.9	5.5	5.2
4.	4.9	8	2.9	2.9	5.5	4.9
5.	2.9	5.4	4.6	5	2.9	0.9
6.	5.3	8.5	5.4	6.9	5	4.7
7.	2.9	2.9	2.9	3.7	4.6	4.7
8.	3.8	4.9	6.3	6.4	—	—
9.	4.5	6	2.9	3.1	—	—
10.	2.9	3.7	—	—	—	—
11.	—	—	—	—	—	—

Note. Seven of the 33 subjects were excluded from the study due to insufficient amount of saliva collected, contamination, or improperly centrifuged samples.

ring is proportional to the antibody concentration (Rider & Weldin, 1990). Effects on the immune system were determined by calculating the difference in the precipitin ring diameters of the before and after samples of the same subject.

Results

Table 1 and Figure 1 show the results of the SIgA assays from the three different groups. Active groups showed an average increase (1.6 ± 1.0 cm) in precipitin ring diameter over the 30-minute session, as did the passive groups (mean = 0.4 ± 0.5 cm). Control groups showed an average decrease in precipitin ring diameter (mean = -0.1 ± 0.3 cm).

A significant relationship between groups and increases in SIgA concentration was found (ANOVA: $p < .01$). A Tukey post hoc analysis was performed and significant differences were found between active and passive groups as well as between the active and control groups (Tukey post hoc: $p < .01$). Average SIgA concentrations were not calculated due to the extreme variance of ring diameters within each group.

Discussion

The findings of this study supported the hypothesis that SIgA concentrations of the active groups showed significantly greater in-

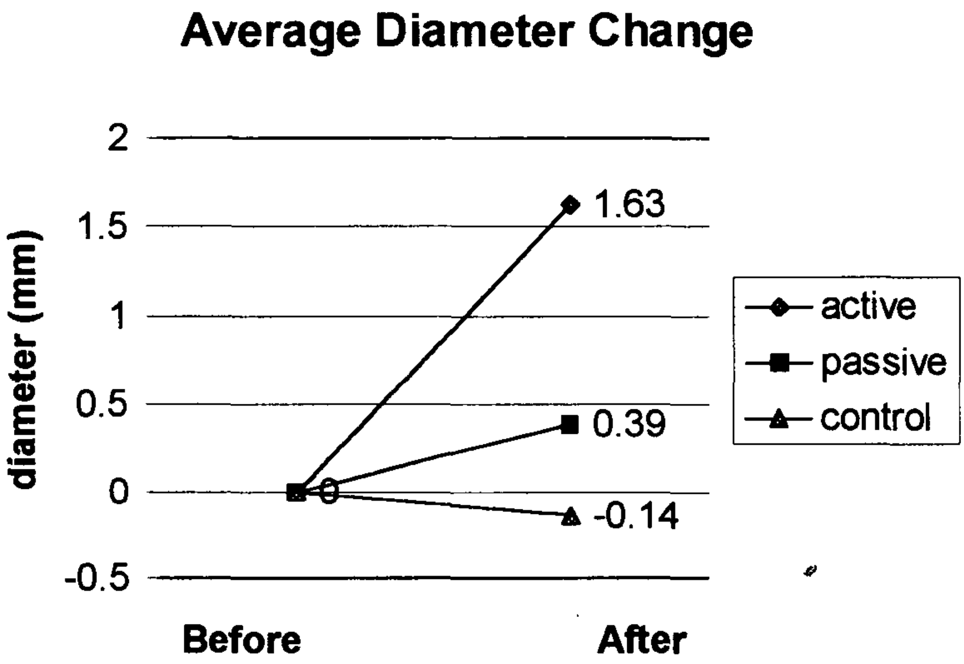

FIGURE 1.
Average change in SIgA (diameter of precipitin ring) by group using 0 cm as the reference point.

creases than those of the control (Figure 1). This suggests that musical activity can increase immune system function within the mouth which is the first line of defense against pathogens of the upper respiratory tract. This is congruent with previous research. SIgA concentrations in the active groups also showed significantly greater increases than those in the passive groups, suggesting that actively participating in the production of music has a greater positive effect on the immune system than music listening alone.

An important consideration of this study was the use of music preferred by the subjects. Preferred music has been found to increase positive sensory experiences (Bartlett et al., 1993). Active groups were set up so as to provide the least intrusive environment for subjects. Improvisational activities were eased into after instrument exploration through call and response activities in order to decrease intimidation. Tone bar activities were performed using a pentatonic scale so as to decrease unintentional dissonance. Perhaps the active role produced a sense of control that is responsible for the increased immune response, future research might address the difference between improvisation and performing a composition by someone other than the participant. Future studies might also tailor the passive music listening group more towards the individual participants by possibly having them choose the musical selections.

Memory and association of previous musical experiences form an individual's response to music (Bartlett et al., 1993). When a person takes an active role in music making, the music produced becomes more personal and can have even greater meaning, thus producing a more intense emotional experience, triggering the release of immune hormones. Specific muscle movements involved in the active groups however were not addressed in either the passive or control groups. Perhaps there exists some correlation between particular motor movements and the release of SIgA. Further research is needed to determine what aspect of active musical participation influences the immune system.

Sample sizes for this study were small, and a large within group variance was seen between the before and after times. Although the average decrease noted in the control groups is supported by previous literature, standard error could also suggest no change or even an increase. The majority of this study was performed in the fall during a time when many students were contracting cold and flu viruses, which could have affected SIgA levels depending on time and frequency of exposure to viruses. Also, the majority of the participants were women, so generalizations of the findings that include all humans might not be accurate. Women might exhibit different immune responses to music than men.

SIgA limits the attachment of bacteria to the epithelial cells of the respiratory and digestive tracts and can also neutralize toxins by blocking their receptors (Marcotte & Lavoie, 1998). By increasing SIgA levels, active music making could be effective in protecting against oral diseases and controlling the equilibrium of the oral resident micro biota. Findings of this study are encouraging and provide further verification of the influence of music on physiological factors and possible insight into the use of music in disease management.

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