

## **Relaxing Music Prevents Stress-Induced Increases in Subjective Anxiety, Systolic Blood Pressure, and Heart Rate in Healthy Males and Females**

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*Previous research suggests that while subjective anxiety is reduced by relaxing music, the effect of music on physiological stress indices is less consistent. In the current study, the effect of relaxing music on participants' subjective and physiological response to stress was explored, with attention paid to methodological factors and mediating variables that might have contributed to inconsistencies in previous studies. Undergraduate students (43 females & 44 males) were exposed to a cognitive stressor task involving preparation for an oral presentation either in the presence of Pachelbel's Canon in D major, or in silence. Measures of subjective anxiety, heart rate, blood pressure, cortisol, and salivary IgA were obtained during rest and after presentation of the stressor. The stressor caused significant increases in subjective anxiety, heart rate, and systolic blood pressure in male and female controls. These stress-induced increases were each prevented by exposure to music, and this effect was independent of gender. Music also enhanced baseline salivary IgA levels in the absence of any stress-induced effects. These findings provide experimental support for claims that music is an effective anxiolytic treatment, the robustness of which is demonstrated by retention of the effect in the presence of a range of potentially mediating variables.*

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Anxiety and stress are normal adaptive responses to potentially dangerous stimuli, with activation of the sympathetic-adrenal medullary system preparing the body for the so-called 'fight or

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flight' response, and the pituitary-adrenal cortical system sustaining a more prolonged coping response (Selye, 1993; Standford & Salmon, 1993). The sympathetic-adrenal medullary system involves the activation of the autonomic nervous system, resulting in the release of adrenal-medullary hormones, noradrenaline and adrenaline. The hypothalamic-pituitary-adrenal system involves the secretion of ACTH from the anterior pituitary in response to corticotrophin releasing factor (CRF) being produced in the hypothalamus. ACTH in the bloodstream subsequently stimulates the release of glucocorticoids and prolactin from the adrenal cortex. Glucocorticoids also inhibit the release and action of cytokines and antibodies, which suppresses the efficacy of the immune system. The persistent activation of these systems is thought to at least partly contribute to stress-related illnesses such as coronary heart disease, reproductive dysfunction, and immunosuppressive disorders (Selye, 1993). Even short periods of anxiety or stress could, however, be detrimental for patients who are about to undergo surgery, or whose health is already compromised postsurgically. In these conditions, even temporary decreases in the immune system due to increased cortisol production, for instance, could impair the patient's capacity to cope with the trauma of surgery, or the challenge of recovery.

A range of factors is known to mediate the effect of potentially stressful events on physiological reactivity. Individual factors such as coping style, social support, personality type, and gender affect the degree of response to a stressor. For instance, Type A behavior pattern individuals have been shown to respond to various stressors with greater increases in cortisol and catecholamine levels, heart rate, and blood pressure than do Type B behavior pattern individuals (Frankenhaeuser, Lundberg, & Forsman, 1980). There has also been consistent evidence that males may be physiologically more reactive to stressful and challenging situations than females (see Frankenhaeuser, 1980; Lawler, Wilcox, & Anderson, 1995). While both genders report increased feelings of unpleasantness and stress in response to a cognitive (Stroop task) and physical (repeated venipuncture) stressor, physiological responses including adrenaline release, systolic blood pressure, and heart rate were found to be significantly greater in males (Frankenhaeuser, Dunne, & Lundberg, 1976; Lawler et al., 1995).

There is now substantial evidence for the anxiolytic (or anxiety-

reducing) effects of music on patients undergoing surgery. Exposure to relaxing music has been found to reduce patients' subjective anxiety levels and physiological stress reactivity in a range of clinical settings (see reviews in Aldridge, 1993; Biley, 2000; Henry, 1995; Standley, 1992). Relaxing or 'sedative' music, which is characterized by slow tempo, repetitive rhythm, gentle contours and strings, has typically been used. This research has quite consistently shown that relaxing music reduces subjective anxiety as measured by questionnaires such as the State-Trait Anxiety Inventory. For instance, Winter, Paskin, and Baker (1994) found that patients in a surgery waiting room who were exposed to preferred music reported significantly lower state-anxiety levels than did patients who waited in silence. Similarly, the anxiety levels of myocardial infarction patients who listened to relaxing classical music were considerably lower than premusic anxiety levels (Updike, 1990), and lower than those of patients who rested without music (White, 1992). However, it is of note that several studies found that the effect of music on anxiety levels of coronary care patients was indistinguishable from that of patients in control conditions (Barnason, Zimmerman, & Nieveen, 1995; Zimmerman, Pierson, & Marker, 1988).

There is less consistent evidence with regard to the anxiolytic effects of relaxing music on physiological indices of stress. In a review covering studies performed between 1906 and 1994, Bartlett (1996) found that while the majority of studies using sedative music yielded a decrease in participants' heart rate and blood pressure, 41% of hypotheses tested with regard to heart rate were not supported. In clinical populations, music appears to quite consistently reduce sympathetic nervous system-related indices of stress (see reviews by Bartlett, 1996 & Standley, 1992). For instance, coronary patients exposed to music showed lower heart and respiratory rates than patients who were not exposed to music (Guzzetta, 1989; White, 1992), and postmusic than premusic (Bonny, 1983). Surgical patients exposed to music showed decreased blood pressure and heart rate (Miluk-Kolasa, Matejek, & Stupnicki, 1996) and a reduction in cortisol levels (Miluk-Kolasa, Obminski, Stupnicki & Golec, 1994) when compared with patients not exposed to music. Similarly, blood pressure and heart rate were found to be reduced more after exposure to music than prior to exposure (Updike, 1990). Finally, immune responses were found to be enhanced in patients exposed to music when compared to patients not exposed to music (Goff, Pratt, & Madrigal, 1997; Lane, 1991).

Laboratory-based studies have more recently confirmed and extended these findings. For instance, relaxing music has been shown to significantly reduce subjective anxiety (Stoudenmire, 1975), reduce cortisol and ACTH levels (Bartlett, Kaufman, & Smeltekop, 1993; Möckel et al., 1994), and increase salivary immunoglobulin A (IgA levels) (McCraty, Atkinson, Rein, & Watkins, 1996; Tsao, Gordon, Maranto, Lerman, & Murasko, 1993) in healthy participants. However, a number of studies have reported no effects of music on physiological indices (Oyama, Sato, Judo, Spintge, & Droh, 1987; Rider, Floyd, & Kirkpatrick, 1985). Other studies suggest that subjective and physiological indices of anxiety may not always be correlated (Davis & Thaut, 1989; Iwanaga, Ikeda, & Iwaki, 1996). Methodological problems, such as small sample size, poor statistical techniques, or absence of adequate controls or baselines, may be partly responsible for the inconsistency across studies (Bartlett, 1996; Biley, 2000; Dainow, 1977). Further, there have been few attempts to measure or control the many factors that could mediate the effect of music on physiological stress reactivity. That is, in addition to the psychological, cognitive and social factors that influence an individual's response to stress noted earlier, an individual's response to a particular piece of music can also mediate the effects of music. In particular, it has been argued that the categorization of music as 'sedative' or 'stimulative' is oversimplistic (Hodges, 1980), and an individual's response to music appears to depend at least as much on factors such as familiarity, preference, current mood, and music training (Abeles & Chung, 1996). For instance, physiological responses are thought to be enhanced when the music is repeated to enhance familiarity (Iwanaga et al., 1996), and when the music is liked or self-selected (Davis & Thaut, 1989; Iwanaga & Moroki, 1999; Stratton & Zalanowski, 1984). A number of studies have also shown that the physiological responses of participants with musical training differ significantly from those without training (Peretti & Swenson, 1974; Vanderark & Ely, 1993). Finally, the physiological responses of female participants to music were found to generally be larger (Goff et al., 1997; Peretti & Swenson, 1974; Standley, 1992) than those of male participants.

The primary aim in the current study was to investigate the effects of music on the physiological reactivity of healthy participants to a cognitive stressor. A relaxing piece of music was selected on the basis of previous research, but the participants' familiarity, liking and perception of the piece as relaxing were also noted.

Since gender has been shown to affect the physiological response to both stress and music, a second aim was to determine whether gender interacted with the effect of music.

## Method

### *Participants*

Eighty-nine undergraduate students were recruited from various tertiary institutions in Victoria, Australia. The majority of students were completing courses in Psychology, Outdoor Studies, Business, or Creative Arts. Two participants withdrew after the experiment was introduced because they found the stressor too threatening, leaving 87 participants (no further participants withdrew during the experiment). Participants consisted of 43 females and 44 males, and ages ranged from 18 to 50 years ( $M = 26.32$ ,  $SD = 7.66$ ). Participants were assigned to small groups of approximately 6 to 12 based on their availability, and these small groups were randomly assigned to the music or no music group. An attempt was made to ensure that an equal number of males and females were in each session. All participants were naïve to the purpose and hypotheses of the study.

### *Materials*

*Music piece.* The music piece used for the treatment was Pachelbel's *Canon in D major* (Claire Hamill, Dino music). This piece was selected as it has been shown to induce relaxation in prior studies (Tsao et al., 1993; White, 1992). The piece (duration: 7 min, 44 sec) was repeated three times to enhance familiarity (Iwanaga et al., 1996) resulting in the treatment period being 23 minutes and 12 seconds. The testing rooms were fitted with a Denon Hi Fi system so that music could be played into the room via a loud speaker system. A prerecorded, high quality audio tape of the music piece was used. The maximum loudness of the music in the room was adjusted to  $72 \pm 2$  dB(A) sound pressure level, and the speakers were situated within a 3 to 5 meter radius of each participant.

*Questionnaires and apparatus.* The State Trait Anxiety Inventory (STAI; Spielberger, 1983) was used to measure both state and trait anxiety levels. A demographic questionnaire was used to obtain information about the participants' age, gender, music training ('yes/no'), and whether they perceived the task as stressful

('yes/no'). Information was also obtained on whether participants were experiencing any cold symptoms. For participants in the music treatment group, additional information collected included familiarity of the piece used ('yes/no'), liking of the piece ('yes/no') used, and whether they found the piece relaxing or not. The demographic questionnaire also screened people for drug use.

An automatic sphygmomanometer (Nissei, Japan) was used to measure heart rate and blood pressure. Saliva samples were obtained using citric salivettes (Sarstedt Inc., Rommelsdorf, Germany). IgA concentration was measured using 12 well low concentration IgA plates and LC-V (human) protein standard serum (Dade Behring).

### *Procedure*

Participants were tested in small groups of approximately 6 to 12 for practical reasons. On entering the testing rooms, the participants sat quietly for 5 minutes to achieve resting baseline measures. A saliva sample was obtained by asking each participant to chew on a cotton wool swab, which was then placed into a salivette tube and kept on ice at 0 to  $-4^{\circ}\text{C}$  for the duration of the procedure. The participants filled out both forms of the STAI, and each participant's blood pressure and heart rate was measured. They were then informed about the stressor, although it was presented as a "task" rather than as a "stressor".

Immediately after the stressor (see below for details), each participant's blood pressure and heart rate was again taken, and the demographics questionnaire and another STAI was completed. A second swab of saliva was collected exactly 20 min after they were told of the stressor, a delay consistent with the time required for cortisol and IgA levels to peak (McCarty et al., 1996; Sharpley & McLean, 1992). The experiments were carried out in the afternoon between 2.00 p.m. and 5.00 p.m. to minimize variability in salivary IgA and cortisol variability (Bristow, Hucklebridge, Clow, & Evans, 1996; Sharpley & McLean, 1992). For participants exposed to music, the music was turned on as soon as all the baseline measurements were completed. It was left on until the beginning of the debriefing session. Participants in the control group performed these procedures in silence. The participants were then debriefed as to the true nature of the research and, in particular, that no oral presentation would actually be required.

*The cognitive stressor.* Participants were told that they would be required to give an oral presentation on a topic related to their area of study. It was implied that they should have a good knowledge of the topic because of their academic background, although a difficult topic was deliberately selected to enhance anxiety (for instance, 'the use of statistics in psychology' for Psychology students). The participants were told that their presentation was to be videotaped by a technical person, and that their performance would be evaluated by two staff members and the student researcher. The task was selected to minimize gender-bias, as both males and females were trained in the area on which they were asked to speak. They were then instructed to be totally silent for a 12-minute period during which they should prepare for their presentation. The participants were told that while preparing for the presentations they must keep in mind that statements must be specific and precise, as the evaluation of the performance would be based on how convincing, enthusiastic, organized, and articulate they were throughout their presentation. After the preparation time they were handed out a timetable listing each participant's putative presentation time. Since the anticipatory stress experienced during preparation for a public speaking task has been shown to itself be a highly effective stressor (Absi et al., 1997), for ethical reasons the experiment was then concluded and participants de-briefed without the oral presentation being given. Post-stressor measures were therefore taken immediately after the preparation time had elapsed and the timetables handed out.

*Cortisol and salivary IgA collection and assays.* Saliva samples were stored at  $-20^{\circ}\text{C}$  until the day of assay. They were then thawed and centrifuged at 1500 rpm/g for 15 minutes. The saliva was then decanted from the salivette to provide a pure sample of saliva. Saliva samples were sent to an independent laboratory (Analytical Reference Laboratories, North Melbourne, Australia) for cortisol assay. The salivary IgA was analyzed by single radial immunodiffusion assaying.

## Results

### *Data Screening*

Data were collated from 87 participants, consisting of 23 females and 22 males in the music group and 20 females and 22 males in

the control group. Data were missing for subjective anxiety levels from 1 participant, for IgA levels from 6 participants, and for cortisol levels from 1 participant. Since the missing data appeared to be randomly distributed across conditions, and there were few cases, these participants were excluded from those particular analyses only. The salivary IgA results for 18 participants who had cold symptoms were also omitted from further analysis, since elevated IgA levels in response to upper respiratory tract infection could mask treatment effects. These participants were fairly evenly spread among the four gender by treatment conditions (5 females and 3 males from the music group, and 6 females and 5 males from the no music group). A check for outliers revealed four extreme values, using the criterion defined by Tabachnik and Fidell (1996). Since these values were still considered to belong to the same distribution as other scores, each outlier was transformed so it sat at the extreme of the distribution and was no longer deviant.

#### *Efficacy of the Stressor*

The efficacy of the stressor was assessed by comparing pre and poststressor measures of participants in the control condition. The mean anxiety levels (STAI units), systolic and diastolic blood pressure levels (mmHg), heart rate (bpm), salivary IgA levels (mg/dl), and cortisol ( $\mu\text{g/ml}$ ) for males and females before and after the stressor are shown in Table 1.

It can be seen that the stressor increased all stress response indices in both males and females. Mixed models ANCOVA revealed significant effects for the repeated factor of time for subjective anxiety,  $F(1,40) = 21.50, p < .001$ , systolic blood pressure,  $F(1,40) = 25.48, p < .001$ , and heart rate,  $F(1,40) = 23.19, p < .001$ . Males displayed higher systolic blood pressure levels,  $F(1,40) = 17.95, p < .001$ , and salivary IgA levels,  $F(1,27) = 6.94, p < .05$ , than did females. However, male and female reactivity to the stressor was similar for all measures, with no significant gender by time interaction effects observed.

#### *The Effect of Music on Stress Reactivity*

The effect of music was investigated in only those measures that demonstrated reactivity to the stressor. Reactivity measures were calculated by subtracting pre-stressor measures from post-stressor



TABLE 1

Means and Standard Errors of the Means (SEM) for Each Measure Pre and Poststressor, for the Control Group (no music) Males and Females only.

Measure	Gender	Prestressor		Poststressor		Stressor effect	Gender effect
		M	SEM	M	SEM		
Subjective anxiety	M	40.10	1.67	48.91	2.43	$p < .001$	$p > .05$
	F	40.20	1.86	46.30	2.27		
Systolic BP	M	121.41	2.72	132.23	2.82	$p < .001$	$p < .001$
	F	107.90	2.63	115.95	3.07		
Diastolic BP	M	70.32	2.09	76.82	2.88	$p > .05$	$p > .05$
	F	65.85	3.07	67.75	7.30		
Pulse	M	75.23	2.16	81.18	2.67	$p < .001$	$p > .05$
	F	74.85	2.39	85.55	2.67		
Salivary Iga	M	0.46	0.06	0.52	0.10	$p > .05$	$p < .005$
	F	0.19	0.07	0.29	0.11		
Cortisol	M	6.11	1.76	16.07	8.86	$p > .05$	$p > .05$
	F	12.68	5.98	19.73	10.14		

measures to provide a difference score. The effect of music on reactivity measures for subjective anxiety, systolic blood pressure and heart rate for males and females is shown in Figure 1.

It can be seen that the significant increase in subjective anxiety (Figure 1a), systolic blood pressure (Figure 1b), and heart rate (Figure 1c) observed in the control condition is absent in the music condition. This effect occurs for both males and females. It also appears that in most instances, there is actually a slight reduction in stress indices below baseline measures. A two-way independent ANCOVA was performed for each reactivity measure, with baseline measures of each variable entered as a covariate. The main effect of music was significant for each measure (subjective anxiety,  $F(1,81) = 30.13$ ,  $p < .001$ ; systolic blood pressure,  $F(1,82) = 10.54$ ,  $p < .005$ ; heart rate,  $F(1,82) = 9.79$ ,  $p < .005$ ). Females displayed higher heart rates than males,  $F(1,82) = 4.19$ ,  $p < .05$ , but an absence of interaction effects indicated that the effect of music on stress reactivity measures was similar for males and females. The amount of variance (adjusted  $r^2$ ) accounted for by this model of predictors was

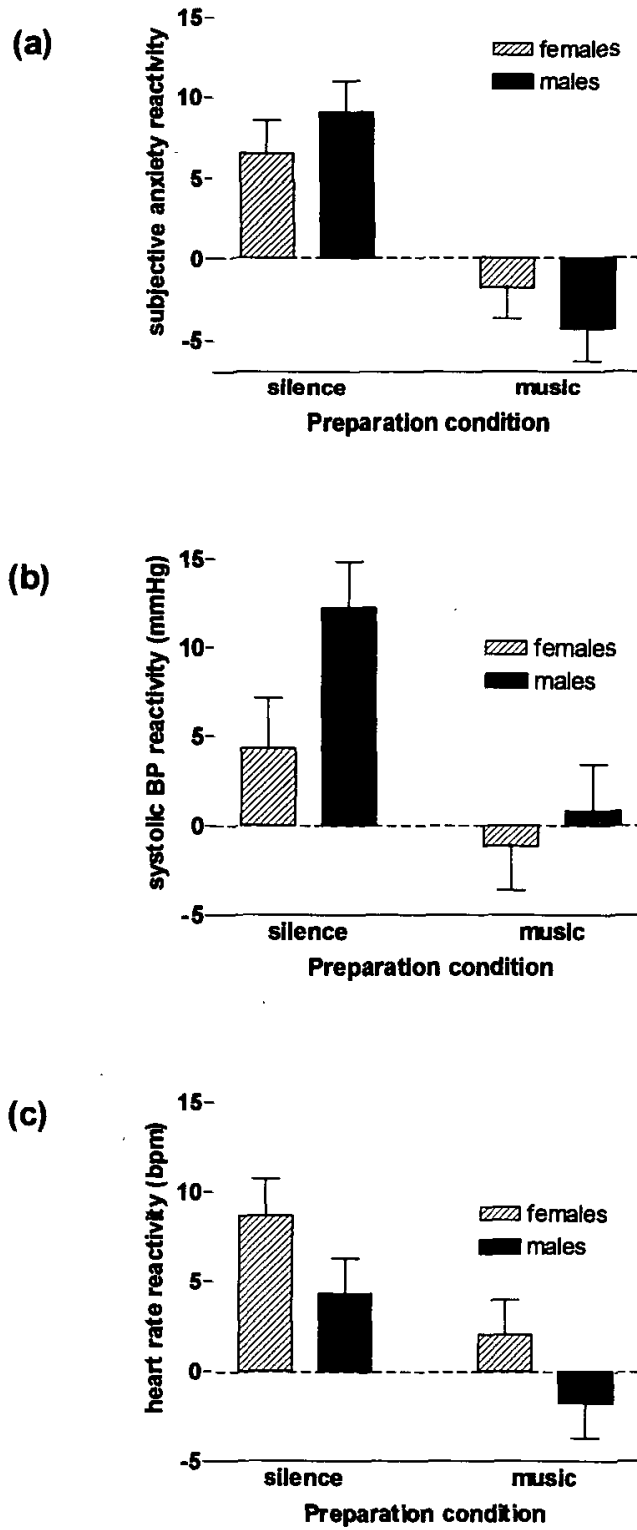


FIGURE 1.

Means and standard errors of the mean for: (a) anxiety rating difference; (b) systolic blood pressure difference; and (c) heart rate difference.

28% for the subjective anxiety measure, 26% for systolic blood pressure, and 36% for heart rate.

While diastolic BP, salivary IgA, and cortisol levels were not significantly affected by the stressor, two-way independent measures ANCOVAs revealed that music significantly reduced diastolic blood pressure levels,  $F(1,82) = 4.82$ ,  $p < .05$ , and significantly reduced salivary IgA levels,  $F(1,58) = 8.82$ ,  $p < .005$ . Music had no significant effect on cortisol levels, and it was noted that standard errors were largest for this measure.

### *Mediating Factors*

Basic data on a range of other variables thought to mediate the effect of music or stress on physiological measures were also obtained, and treated by exploratory analyses. The effect of music on subjective anxiety, systolic blood pressure, and heart rate retained significance regardless of participants' liking of the piece (95.6% liked the piece), familiarity with the piece (75.6% were familiar with the piece), and whether they found the piece relaxing or not (93.3% found the piece relaxing). No significant interaction effects were observed between the music treatment variable and either music training (29.90% were 'trained'), age or trait anxiety level. While not significant, trends indicated that the effect of music was stronger for participants who were unfamiliar with the piece and had no musical training, than for those familiar with the piece and those with musical training.

Finally, 42% of participants indicated that they did not perceive the oral presentation preparation task to be stressful, when responding to a dichotomous 'yes/no' question. Mean reactivity scores indicated that these participants did in fact react considerably less to the stressor than did participants who perceived the task as stressful (subjective anxiety: 10.42 points less; systolic blood pressure: 7.31 mmHg less; heart rate: 3.91 bpm less). These participants still displayed lower subjective anxiety, systolic blood pressure, and heart rate if they experienced the stressor in the presence of music than in silence, however, the 'perception of stressor' by music interactions for both the subjective anxiety,  $F(1,81) = 3.91$ ,  $p = .051$ , and systolic blood pressure,  $F(1,81) = 3.88$ ,  $p = .052$ ) measures approached significance. This reflects the considerably larger effect of music on stress reactivity (as measured by subjective anxiety and systolic blood pressure) of participants who perceived the

task as stressful, compared with a minimal effect for participants who did not perceive the task as stressful.

### Discussion

The current study demonstrates that exposure to Pachelbel's *Canon in D major* was capable of preventing the significant increases in subjective anxiety, systolic blood pressure, and heart rate caused by a cognitive stressor. This effect of music on stress reactivity was surprisingly large and robust, occurring in the presence of a range of moderating variables. In addition, the music piece attenuated diastolic blood pressure and salivary IgA levels, independent of a stress response.

The major finding that a relaxing piece of music reduces subjective anxiety is consistent with the majority of previous research (Stoudenmire, 1975; Thaut, 1989; Updike, 1990). Patients consistently report that they feel less stressed when music is present, and participants exposed to laboratory-induced stressors also report lower levels of state anxiety in the presence of music than in its absence. The finding that music also prevents stress-induced changes in physiological measures is, however, more noteworthy. Research in this area has been quite inconsistent, particularly with regard to blood pressure and heart rate indices (Bartlett, 1996). Several factors may account for the more robust effect observed in the current study. First, a moderate sample size was used, and the experimental setting enabled consistency of conditions across participants. This would have reduced variability considerably. Secondly, participants' baseline measures were entered as covariates in the analyses, which enabled the individual variation in for instance, body weight, and fitness to be taken into account. Thirdly, the music piece was played repeatedly to participants, following suggestions by Iwanaga et al. (1996) that repetition would produce a more stable change in physiological responses. Finally, the majority of the participants were familiar with and liked the piece used, which previous researchers have suggested makes a piece more relaxing (Davis & Thaut, 1989; Iwanaga & Moroki, 1999; Stratton & Zalanowski, 1984). The current findings, therefore, lend experimental support to a number of clinical studies and reviews that have reported that music reduced sympathetic nervous system indices of stress (Guzetta, 1989; Miluk-Kolasa et al., 1996; Standley, 1992; White, 1992).

The observation that music increased baseline salivary IgA levels is also consistent with previous research (Goff et al., 1997; McCraty et al., 1996; Tsao et al., 1993), although the absence of a stress response in this physiological index was not anticipated. In this context, it is of interest that the type of physiological response to a stressor is to some extent dependent on the perceived degree of control one feels over the stressor (Frankenhaeuser, 1982). The sympathetic-adrenal system appears to be preferentially activated when a stressor is perceived as within one's control, or as a challenge. In contrast, the hypothalamic-pituitary axis is more sensitive to a stressor perceived as beyond one's control, or as distressing. Since all participants in the current study were volunteers who knew the task would not affect their course results and were aware that they could leave the experiment at any time, the stressor used in the current study would probably have been perceived as 'challenging' rather than 'distressing'. It is therefore perhaps not surprising that the sympathetic nervous system indices (heart rate, blood pressure) were activated more strongly than the pituitary responses (IgA and cortisol).

The current data are, however, inconsistent with previous research showing that music can also decrease cortisol and ACTH levels (Bartlett et al., 1993; Möckel et al., 1994). No effect of either stress or music was observed on cortisol levels. Saplosky (1994) has reviewed a range of psychological factors that lead to individual variability in glucocorticoid responses, and it is possible that the high variability in cortisol measurements in the current study masked effects. Alternatively, this cognitive stressor and this particular music may simply have no effect on cortisol levels. The lack of correlation between the IgA response and cortisol is not unusual (Kugler, Hess, & Haake, 1992), and implies that the increase in IgA levels was mediated by a source other than cortisol. Since salivary IgA production takes several days to complete *de novo*, it is likely that the rapid changes observed in the current study reflect the release of IgA from an existing accumulation that can be rapidly accessed (Bristow et al., 1996).

The finding that the anxiolytic effect of music was independent of a range of potentially mediating factors was also somewhat surprising, particularly with regard to previous evidence of a gender effect in physiological stress reactivity (Frankenhaeuser et al., 1976; Lawler et al., 1995) and in responses to music (Goff et al., 1997;

Peretti & Swenson, 1974; Standley, 1992). While there were gender differences in baseline levels of systolic blood pressure and IgA levels, reactivity to the stressor was similar for both genders. Interestingly, Collins and Frankenhaeuser (1978) found that the gender difference consistently observed in response to stressors was significantly reduced in situations where females adopted 'male' gender roles. For instance, female engineering students experienced a similar increase in adrenaline levels to a cognitive stressor task as did their male counterparts. The courses in which the students in the current study were enrolled could also be considered to encourage similar gender roles across males and females (for instance, Outdoor Studies may promote a 'male' type gender role and Psychology more a 'female' type gender role), which may account for the similar responses to the stressor. Future studies could investigate the effect of music on stress reactivity in students enrolled in less gender stereotyped courses. It is important to note, however, that while gender was not found to mediate the effect of music on physiological responses, together the variables of music, gender, and baseline measures accounted for less than 40% of the variance measured in each physiological index. Clearly, there are additional variables not identified in the current study which mediate the effect of music on an individual's physiological reaction to stress.

It was anticipated that factors such as familiarity and liking of the piece, trait anxiety, and music training might have also mediated the effect of music on stress reactivity. Previous research has indicated that the effect of music on physiological responses is enhanced by familiarity and liking (Davis & Thaut, 1989; Iwanaga & Moroki, 1999; Stratton & Zalanowski, 1984), and if participants have musical training (Peretti & Swenson, 1974; Vanderark & Ely, 1993). It is not possible from the current study to evaluate the influence of familiarity or preference of the piece used, since such a small percentage of participants did not like or were unfamiliar with Pachelbel's *Canon*. Nonetheless, it is interesting that the non-significant trends suggest the reverse in this study, in that the effect of music appears to be more pronounced in participants who were unfamiliar with the music and had no musical training. Each of these variables would be worthy of further investigation using more sophisticated measuring instruments than the dichotomous measures used in the current study.

Importantly, the anxiolytic effect of music was much greater for

participants who perceived the oral presentation preparation task as stressful. This is not surprising given that participants who indicated that they were not stressed by the task reported negligible subjective anxiety, and showed much smaller physiological responses to the stressor. However, it is noteworthy that music exposure still appeared to prevent the modest physiological reactivity, despite participants' failure to acknowledge their stress. This finding is encouraging in that even though the effect of music will be greatest for those who are experiencing the most stress, it may still be effective in reducing even mild physiological reactions to stress.

The current findings provide clear experimental evidence that a music treatment can be used to prevent significant increases in subjective anxiety, heart rate, and systolic blood pressure. Whether this effect is due to music *per se* cannot be concluded from the current data, since only one piece of music and one control condition was used. It is possible that the effect was, for instance, due to auditory stimulation, or to the repetitive nature of the stimulus, rather than its musical characteristics. The relaxing effect of the music could have been simply due to the masking nature of the music rather than to its musical characteristics, or the music could even have enhanced cognitive performance while preparing the task (Rauscher, Shaw, & Ky, 1995). It would be of interest to investigate this possibility further in future studies by including nonmusic controls that are also auditory and repetitive in nature (for instance, a comedy sketch repeated twice). Similarly, it would be of interest to observe the effects of 'relaxing music' from other genres other than from the Baroque period, to determine whether the effect is generalized.

In conclusion, the current study provides promising support for the use of music as a powerful anxiolytic treatment. The health benefits of preventing moderate reactions to cognitive stress are considerable, particularly in situations in which a patient's health is already vulnerable or compromised, such as prior to surgery (Miluk-Kolasa et al., 1996), in acute and coronary care settings (Bonny, 1983; Guzzetta, 1989), during postsurgical recovery (Good, 1995), or during painful medical procedures such as chemotherapy (Weber, Nuessler, & Willmanns, 1997). Similarly, frequent exposure to cognitive stressors in a work situation or during an examination period could result in repeated elevations in cardiovascular activity, and potentially hypertension (Pickering, 1997; Weidner & Messina, 1998). Music treatment may provide a simple,

safe, and effective method of preventing the potentially harmful physiological concomitants of the stress reactions.

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