Effects of Music on Cardiovascular Reactivity Among Surgeons

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Objective.—To determine the effects of surgeon-selected and experimenter-selected music on performance and autonomic responses of surgeons during a standard laboratory psychological stressor.

Design.—Within-subjects laboratory experiment.

Setting.—Hospital psychophysiology laboratory.

Participants.—A total of 50 male surgeons aged 31 to 61 years, who reported that they typically listen to music during surgery, volunteered for the study.

Main Outcome Measurements.—Cardiac responses, hemodynamic measures, electrodermal autonomic responses, task speed, and accuracy.

Results.—Autonomic reactivity for all physiological measures was significantly less in the surgeon-selected music condition than in the experimenter-selected music condition, which in turn was significantly less than in the no-music control condition. Likewise, speed and accuracy of task performance were significantly better in the surgeon-selected music condition than in the experimenter-selected music condition, which was also significantly better than the no-music control condition.

Conclusion.—Surgeon-selected music was associated with reduced autonomic reactivity and improved performance of a stressful nonsurgical laboratory task in study participants.

Although we do not know about surgeons specifically, we do know something about the effects of music on psychophysiological responses in general. Peretti et al7,16 measured galvanic skin response and reported that music had a calming effect during a stressful task. Stoudemire17 demonstrated the role of music in reducing state and trait anxiety comparable to muscle relaxation training. In some cases, certain types of music have been associated with decreased physiological responses during stress,18,20 although others have failed to demonstrate this relationship.21,25 Music has also been associated positively with performance on stressful tasks. Recently, Rauscher et al26 reported that subjects' spatial task performance was enhanced when preceded by a Mozart sonata compared with silent or relaxation audiotape control conditions.

Ethical and practical concerns limit the use of a true field experiment to test the hypothesis that music reduces surgeon stress and enhances surgical performance. Consequently, we decided to examine this assumption by modifying a standard psychophysiological laboratory paradigm26-29 to include music as an independent variable and surgeons as participants. To determine whether music effects are specific to subjects' music preferences or simply the presence of music, we included three music conditions. Our specific predictions were that music would reduce autonomic reactivity (ie, skin conductance, blood pressure, and pulse rate) and enhance performance while physicians experienced a standard psychophysiological stressor (serial subtraction).

Methods

Subjects and Setting.—Participants were 50 male surgeons ranging in age from 31 to 61 years (mean, 52 years) who volunteered for the study because of their interest in learning about physiological responses to music. All were self-reported music enthusiasts who regularly listened to music during surgery. All were free of cardiotoxic medications. The experiment was performed in a soundproof hospital research laboratory.

Design.—Music was varied in three conditions within each subject. Each participant performed two serial subtraction tasks in music-free, self-selected, and investigator-selected (ie, Pachelbel's Canon in D) music conditions. The latter is an orchestral piece often used in commercially available “stress-reduction” tapes. Order of music conditions was counterbalanced across subjects.

Stressor.—A serial subtraction task was used as the stressor in this study. The task required subjects to perform aloud rapid serial subtractions of a specified value from a large number. This type of mental arithmetic task has been used in numerous laboratories.26,30-32 These studies have demonstrated that task performance typically induces substantial increases in autonomic responses from baseline resting values.

Physiological Recording Apparatus.—Skin conductance responses were recorded using laboratory equipment (Grass model 7D polygraph with a skin conductance coupler). Fluctuations in skin conductance exceeding 0.05 micromho during each 20-second period were later tallied by experimenters blind to the music condition. Blood pressure was measured from the index finger of the subject's left hand using a blood pressure monitor (Health Check CX-1). Pulse rate was measured and recorded using a photoplethysmographic pulse meter (Panasonic model NKM 017).

Procedures.—Surgeons were scheduled individually by telephone to participate in this experiment and were re-
When surgeons returned, the same procedures were followed except that the music condition was changed, and the values to be subtracted during the mental arithmetic tasks were changed to 52s and 57s. After the second phase, the participants were dismissed while the third phase was set up. On the surgeons’ return, the procedures were repeated a third time except that the music condition changed and the values to be subtracted changed to 43s and 47s.

Results

Physiological Responses.—Four data analyses were performed using a 3x2x2 randomized factorial analysis of variance (ANOVA) design, one for each dependent physiological measure (ie, skin conductance response, pulse rate, diastolic blood pressure, and systolic blood pressure). The within-subject factors were music condition with three levels (no-music control, surgeon-selected music, and experimenter-selected music control), task with two levels (first vs second serial subtraction), and period within task with two levels (rest vs task). Figure 1 depicts the cell means of the physiological responses according to the 3x2x2 design.

The overall ANOVAs (Table) revealed the same pattern of effects for all physiological measures, including main effects for all within-subject variables (music condition, task, and period) as well as music condition by task and task by period interactions. The difference between music conditions was greater during task performance than at rest for all physiological responses. Further, a posteriori tests revealed reliable differences during both baseline and task period, such that all autonomic responses were highest during the no-music control condition, next highest during the experimenter-selected music control condition, and lowest during the surgeon-selected music condition (P<.02; see Table).

Performance Data.—The surgeons’ performance on each task was categorized by speed (fast vs slow) and accuracy (accurate vs inaccurate). A laboratory assistant, who was blind to the experimental conditions, listened to all the subjects’ serial subtractions and rated their task performance.

Separate analyses were performed using a 3x2 randomized factorial ANOVA design for music condition and minutes within each subtraction task. These within-subject factors were analyzed by looking at music condition with three lev-
els (no-music control, surgeon-selected music, and experimenter-selected music control) months in task by minute 1 and minute 2. The overall ANOVAs revealed identical patterns of effects for speed and accuracy, including main effects for both within-subject variables (music condition and minutes) and a music condition by task interaction (Figure 2). Further, a posteriori t tests revealed that both speed and accuracy were significantly better in the surgeon-selected music condition than the other two music conditions (all P < .001).

Comment

This study examined the effects of music on surgeons’ psychophysiological responses and performance during a standard psychological stressor, mental arithmetic. We believe surgeons have never been studied in this context. The results provide evidence that for this group music can have beneficial effects both autonomic and behaviorally.

The beneficial autonomic effects of music demonstrated herein were derived largely from the reduced cardiovascular reactivity during task performance. Considerable evidence exists in support of the relationship between cardiovascular reactivity and cardiovascular disease, particularly coronary heart disease and hypertension.33-35 The beneficial behavioral effects of music demonstrated herein were derived largely from improved task performance. To the extent that surgeons’ performance and cardiovascular responses during a standard laboratory psychological stress task generalize to the surgical suite, one would expect beneficial effects of the same music on both cardiovascular reactivity and performance during surgery.

The participants in our study endorsed this view. They gave many examples of the frequent and enduring stress they experience during surgery. It is important to note that all participants believed in the beneficial effect of music and were eager to participate in our study. We cannot speculate whether music would have beneficial effects for surgeons who customarily choose not to listen to it during surgery or for surgeons who might listen to music but are not devoted music enthusiasts.

No specific category of surgeon-selected music was associated with favorable psychophysiological responses and improved task performance. Individuals were most positively affected by the music they chose, regardless of its tempo, timbre, or instrumentation. Study participants chose 50 different pieces, all instrumental (46 classical, two jazz, and two Irish folk). This extensive variability gives us incredible support for the importance of individual taste and selection of music. An example of this is the more positive influence James Galway and the Chiefans playing traditional Irish music, complete with drums and tin whistle, had on one surgeon as compared with Pachelbel (the control music condition).

These findings raise interesting issues regarding possible mediators of the relationship between music and performance. We contend that preference and not just familiarity contributed to the favorable performance responses and begin physiological responses in the self-selected music condition, since Pachelbel was not related to better performance and only somewhat to decreased physiological reactivity. Accordingly, the self-selected music may have caused the surgeons to feel better able to perform the experimental stress task because of the past association of this specific music with performance during surgery. Our position depends, of course, on the assumption that there was nothing particularly distracting or otherwise negative about the experimenter-selected music, Pachelbel, and that any other selection from the same genre would have produced similar results.

In this study, we demonstrated evidence that listening to music is related to improved autonomic responses and performance during stressful tasks. Also, support was found for our surgeon subjects’ intuitive beliefs that music is beneficial during stressful tasks. In 1889 Nietzsche wrote, “Without music life would be a mistake.”36 Over a century later, our data prompt us to ponder if, without music, surgery would be a mistake.

References