Music-Listening and Stress: The Effects of Music-Listening on Autonomic Nervous System Activation Prior To and During a Stress-Inducing Task

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Introduction

The role of music-listening as an accessible, low-cost therapeutic intervention is most prominent in the field of music therapy, which promotes music and rhythm training in areas ranging from stroke rehabilitation and dementia to developmental and behavioral disorders. Music has also been studied for its potentially ameliorative role during sympathetic stress activation. To date, no studies have looked at the physiologic benefits of music listening during sympathetic stress activation in medical students.

Research Question

Does music-listening affect the physiologic stress response of medical students prior to and during a stress-inducing task? **We hypothesize that music-listening prior to a stress-inducing task will have autonomic physiological responses indicative of higher parasympathetic activation over sympathetic activation.** The primary outcomes are heart rate, heart rate variability, and respiratory rate of medical students. Secondary outcomes are subjective levels of stress and anxiety among medical students.

Materials and Methods

- This was a randomized controlled trial measuring the effects of music-listening or silence on the stress response of medical students during a stressor (the stressor being the diagnostic Step 1 exam).
- The study protocol was approved by an independent review body, and written informed consent was obtained from all subjects.
- Eighteen second-year medical students were recruited from the University of Arizona College of Medicine, Phoenix, in September 2018.
- While studying, one group listened to self-selected music using headphones and a phone or computer, while the other group studied in silence. The students proceeded to take an exam immediately after the study period.

- Physiologic data were recorded via the BioHarness™ data logger and telemetry system over a period of four hours, including a twenty-minute study period prior to the stressor, and during the diagnostic Step 1 exam in October 2018.

BioHarness Module, attached to chest strap with optional shoulder straps

Figure 1: BioHarness™

- The outcome measures, heart rate, heart rate variability, and respiratory rate, were reported as means and standard deviations between participants in the no-music and music groups. All data analyses were conducted using STATA, version 15.
- The Wilcoxon rank sum test was used to assess differences between the two groups. The Wilcoxon sign rank test was used to compare outcome measures between each time point, within each group. The linear mixed model was used to estimate the mean difference in outcome measures between the two groups across three time periods.
- Qualitative data was assessed via the Perceived Stress Scale (PSS) and a pre-test and post-test questionnaire regarding types of coping methods and preferred music while studying.

Results

Over the course of two days, we collected data from a total of eighteen participants. Data was analyzed from seventeen participants due to battery issues with one BioHarness device. We looked at **minimum and maximum values** of three parameters over **three time periods: heart rate (HR), heart rate variability (HRV), and respiratory rate (RR).**

Period 1	5 minute baseline
Period 2	20 minutes of studying
Period 3	20 minutes of the exam

Table 1: Periods of data analysis

|	Music	No Music
Number of Subjects	9	8
Median age	25.4	27.5
Gender		
• Male	3	2
• Female	6	6

Table 2: Subject details

- **For heart rate**, the max and min HR were lower in the music group compared to the non-music group, though only statistically significant for max HR during Period 3.
- **For heart rate variability**, the max and min HRV were greater in the music group compared to non-music group during Period 2 and Period 3, but these results were not statistically significant.
- **For respiratory rate**, there was no significant difference between music group and no music group during either of the three time periods. This was true for both max and min RR.

	Time	Music	No Music	p-value
Minimum HR (bpm): mean ± SD	Period 1	72.8 ± 5.09	76.6 ± 6.67	p <0.19
	Period 2	67.8 ± 6.69	72.8 ± 7.97	p <0.13
	Period 3	67.4 ± 6.76	73.6 ± 12.2	p <0.22
Maximum HR (bpm): mean ± SD	Period 1	90.9 ± 12.4	96.8 ± 7.56	p <0.21
	Period 2	90.9 ± 9.10	100.6 ± 9.91	p <0.059
	Period 3	**88.4 ± 7.10**	**101.8 ± 11.3**	**p <0.008**

Table 3: Min and max heart rate between groups across time

Most Popular Types of Music Used During Period 2
■ Pop ■ Classical/ Piano ■ Alternative/ Indie ■ Rap ■ Rock
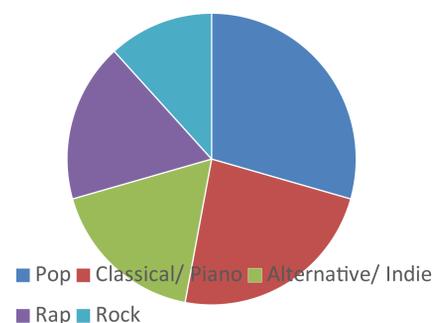
"Do you listen to music while studying?"
■ Yes ■ No ■ Depends
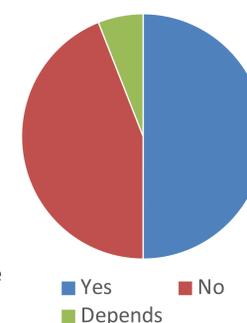
Social	Time/ conversations with family Reading Listening to music/ podcasts Watching YouTube/ Netflix
Physical	Exercise (walking, running, working out) and going outdoors
Psychological	Motivational thoughts Breathing techniques Meditation/ power poses

Table 4: Types of coping methods utilized by medical students

Conclusion

- Our results supported the hypotheses that medical students listening to music while studying for an immediate exam would have a different stress response, measured by heart rate, heart rate variability, and respiratory rate, compared to medical students who didn't listen to music.
- During the exam, **the music group had a mean maximum heart rate of 88.4 bpm compared to 101.8 bpm (p = 0.008).** Across three time periods, **the mean maximum heart rate was 9.75bpm lower in the music group compared to the no-music group (p = 0.008).**
- Though not statistically significant, our study showed a lower minimum heart rate during the study period and exam period.
- Participants reported several coping methods for stress and anxiety that we categorized into social resources, physical resources, and psychological resources. Pop music seems to be the preferred music choice of this group.

Summary

Among a small sample of medical students, music-listening was associated with a lower maximum heart rate during the stress-inducing task of taking an exam.

Acknowledgements