

# The effects of music on astronaut stress

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## ABSTRACT

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Astronauts face a number of physical and psychological challenges, some of them being confinement and isolation. These two factors can lead to underlying stress. This puts the mission at risk. Music could be an efficient solution to this problem as it costs very little, takes up very little space and could be easily tailored to every individual. This experiment carried out in the Mars Desert Research Station, measured heart parameters and questionnaires as indicators of stress, the main variable being music chosen by the astronauts. The experiment does not have conclusive results as it was limited by the number of participants, the lack of time and some imprecise protocol.

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## 1 Introduction

Astronauts face a number of physical and psychological challenges, some of them being confinement and isolation. These two factors can lead to underlying stress. Homesickness, tension in the team or difficulties in the mission, a need for personal space, different physical changes in the body etc. can all lead to a state of emotional and psychological discomfort thus creating tension and stress in the astronaut. This stress is not always conscious and the fact that it could be underlying makes it even more dangerous to the mission as it could result in surprising behaviour of the affected astronaut or tension in the team. This puts the mission at risk. It has been studied that music could be an efficient solution to this problem [1]. It could be very interesting as it costs very little, takes up very little space and could be tailored to every individual. In this experiment, each astronaut chose a song

they feel like they can relax to. This decision was based on two studies [2] [3]. During the two-week mission, the astronauts were isolated 10 min every other day for a relaxation session during which they some days listened to their chosen music. To measure the stress, heart variability (HRV) was measured thanks to the KINO and the HRV4TRAINING apps, heart frequency and tension were measured thanks to a blood pressure monitor, self-percieved stress was measured by the Self Percieved Stress Test (PSQ) [4] and subjective feedback and preference was collected by a self made post mission questionnaire.

## 2 Methods and materials

### 2.1 Method

Initially, the idea was to do the experiment on every astronaut every day, but due to lack of

time and scheduling, it had to be changed to every other day for a single astronaut. It also meant that of the 8 subjects, 4 had to be experimented on days A and 4 had to be experimented on on days B. In total, each subject had 7 or 8 measurements, with some subjects having extra daily measurements in the last 3 days of the mission due to availability in their schedule. In the end, only 6 measurements were kept per person due to the invalidity of the first measurement due to a technical problem with the KINO app which will be detailed later on.

Each session was 15 minutes long. First, there would be 5 min of heart resting time. This period was useful to bring the heart to a normal resting state. The subject would lay on their back, eyes generally closed, with earphones on. Then there would be 5 min of stimulus. On some days, that meant that music would be played and some days it meant silence. The presence or not of a stimulus was decided randomly with the only condition being that half of the sessions should have music and the other half shouldn't. The subject would not know in advance if they had a music or silence session. The 5 final post-stimulus minutes are used to analyse if the music or lack of music had a continuous or post effect. If there was music, it would stop, the subject would lay in silence for the remaining time. Same if there was no music, the silence would just continue, headphones still on. Heart measurements were taken during all three phases of the experiment.

The heart measurements taken were heart variability, cardiac frequency and blood pressure. The self perceived stress test was taken before every session started and the appreciation survey was taken once, a week after the mission, so a week after the last session.

## 2.2 Material

The material used for this experiment was the following. A bed, on which the subject could lay down to relax. It would always stay the same bed, from the beginning to the end of the experiment. A blood pressure monitor for the cardiac measurements except for HRV. For HRV, we partnered with HeartKinetics in order to use their KINO app. This app makes it possible to measure HRV only by putting the device, in this case a smartphone, onto the subject's chest and pressing a button. It was used for the first measurements but then suddenly had a technical malfunction. Later on and through to the end, the app had to be changed to HRV4TRAINING which uses similar technology. To not have to account for the change in measurement method and the different ways the apps measure HRV, the first measurements were dismissed and only those done with HRV4TRAINING were kept. Personal earbuds or earphones were used by the subjects to listen to their chosen song. This song had to be chosen individually by the subject and had to be a song they felt like they could relax to. A computer was used to collect data as well as to perform the PSQ [4]. After the mission, the appreciation survey was created by Ioana Dimitrova and carried out on Google Forms [5].

## 3 Results

For ethical reasons, results could not be analysed individually but rather merged together to give a group analysis. Here are the results :

### 3.1 Heart parameters

#### 3.1.1 Heart variability

Two analysis were done on this parameter. The first one was to try to see if the overall group results were different on the days where individuals had sessions with music and on the days without music. (Important : those days were not the same for everyone). Because everyone's normal rates and values are different, it was important to measure the variation between the average HRV of a crew member and not the just the average of the HRV values obtained. The global change in HRV between the resting HRV and the stimulus HRV for days without music was 12,988 ms and 1,4219 ms for days with music. Usually, a higher HRV indicates a better stress resilience. The numbers obtained here are not significant so no conclusion could be made.

The second analysis was made after realising that music probably did not have that big of an effect, thus after the first analysis. The goal was to see how the team's HRV evolved during the two weeks of simulation, regardless of music. The graphs obtained showed no visible trend or interesting pattern.

#### 3.1.2 Heart rate

The same two types of analysis were made as in HRV. The global change in heart rate pre-stimulus and post-stimulus for days without music was -0,2813 bpm and for days with music was -0,2031 bpm. So no significant change in heart frequency. (In this article, the term "heart frequency" is used as a synonym for

"heart rate". The measurement unit for both is bpm.

The second analysis showed no visible trend or interesting pattern in the evolution of group heart frequency regardless of music.

#### 3.1.3 Blood pressure

**Systolic blood pressure** The same two types of analysis were made as in HRV. The global change in systolic blood pressure pre-stimulus and post-stimulus for days without music was 3,17708 mmHg and for days with music was 3,36979 mmHg. So no significant change.

The second analysis showed no visible trend or interesting pattern in the evolution of group systolic blood pressure regardless of music.

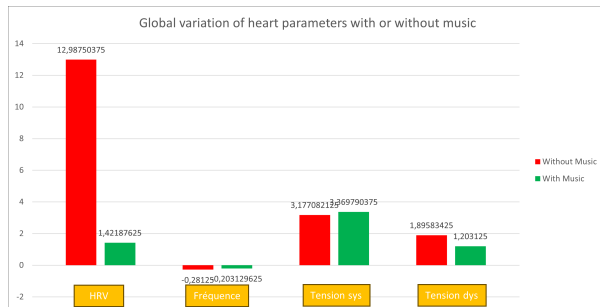
**Diastolic blood pressure** The same two types of analysis were made as in HRV. The global change in diastolic blood pressure pre-stimulus and post-stimulus for days without music was 1,89583 mmHg and for days with music was 1,20313 mmHg. So no significant change.

The second analysis showed no visible trend or interesting pattern in the evolution of group diastolic blood pressure regardless of music.

All of these results are illustrated on [figure 1](#)

### 3.2 Self-perceived stress questionnaire

The perceived stress questionnaire used is based on the PSQ30 designed by Fliege, H.,

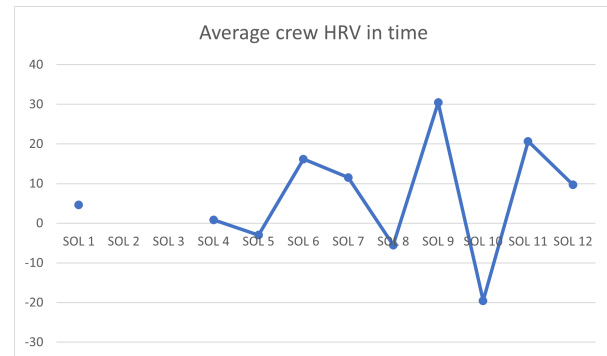


**FIGURE 1** – Global variation of heart parameters with or without music

Rose, M., Arck, P., Levenstein, S. & Klapp, B. F. (2009) to study subjective stress. Only a couple of questions were adapted to fit the mission circumstances. The goal of it was to see if the stress measured in the heart parameters was correlated to the subjective feeling of stress and how the mission affects this subjective stress. So this part is not directly linked to music but more to see if the stress felt could also be measured by the heart parameters.

The test was performed before each session and has 30 questions with answers given on a scale from 1 to 5. At the end, a stress coefficient value between 0 and 1 is obtained. 1 being extremely stressed and 0 being not at all stressed. This data was then analysed to show a graph of how this perceived stress evolved during the mission. Because it's subjective and a certain value on the scale has a different meaning to each individual, it was important to measure the variation compared to the average stress coefficient of a crew member and not the just the average of the group stress coefficients obtained. The graph obtained is the one on [figure 2](#)

It does not correlate with either one of the time graphs obtained for the heart parameters which means that a direct link between the



**FIGURE 2** – Average Crew HRV in Time

measured and perceived stress was not found. By analysing this graph, some spikes could be explained by events that happened during the mission. After consulting mission logs and private diaries, the three downward spikes could be explained. SOL 2 was the day one of the suits malfunctioned, the KINO app stopped working, too much water was used and the reports sent in were criticised heavily. SOL 6 was the day the crew accidentally made a very big mistake in one of the reports that could have damaged the simulation. SOL 9 was a day during which everyone was feeling slightly down.

### 3.3 Appreciation survey

The appreciation survey taken two weeks after the mission was created by Ioana Dimitrova and its main goal was for the crew members to reflect on how the sessions and the music they listened to affected their mission. The crew reported that they felt slightly more relaxed after the music sessions compared to the silent sessions with results 4 out of 5 compared to 3,42 out of 5. 85,7 percent said they preferred the music sessions to the silent sessions and the remaining 14,3 percent had no preference. The reasons for this preference, expressed in the questionnaire were that music helps to be

more isolated from other noise, that it helps to feel transported elsewhere and thus balances the feeling of confinement and that is makes the members feel positive emotions.

57,1 percent said their mission would have been less successful without these sessions, with or without music. When explaining why, most of them agreed that they were useful as many would not have taken this time to relax or recenter their mind on their own, without it being an obligation. They said it released some tension personally for them and that helps them to be in good shape individually but that it also benefits the team in the long term because it gives everyone the opportunity to have a clear mind before they tackle problems together.

#### 4 Conclusion

Based on these results, we could come to several conclusions. The variation in heart parameters between the music sessions and silent sessions is not big enough to conclude that music has an effect on heart parameters and especially on HRV, which is directly linked to stress. Also, there seems to be no evident trend in heart parameters throughout the mission which gives us no insight in how stress could evolve during the mission. These heart parameter time graphs also do not correlate with the self-perceived stress graph, which proves no direct link. The results received from the self-perceived stress test do in fact correlate with some significant events that happened during the mission. The appreciation survey show that crew members found the relaxation sessions helpful and preferred the music ones as they felt more relaxed afterwards.

Unfortunately, these results should be interpreted with caution. Several factors have to be taken into account and in hindsight many things could have been done differently to obtain more reliable results. First of all, due to scheduling issues, not everyone could be tested every day, which gives us incomplete data. Also, due to occurring malfunctions or time problems, not everyone could do their session at the predicted moment. The session must be done at the same hour every time because other factors such as circadian rhythms could interfere. This was not respected 100 percent of the time and some sessions were even skipped, which means the data is incomplete. Second of all, in this experiment, the music choice was based on every individual's personal choice. They were asked to choose a song that relaxes them. On one side, it makes us hope that the song will be more efficient as everyone is relaxing could be subjective. But it also means that some people could have made a more emotional song choice that brings up some feelings which could mislead the results. Maybe choosing a neutral song that everyone finds relaxing, such as spa music for example, could help have one less of a factor that could influence the results. Thirdly, better measurement instruments could be used to be more precise. Here, the idea was to collaborate with a company and to test new technology. Unfortunately, the app malfunctioned which forced us to use a new one. This technology is new and maybe not precise enough yet. Finally, scheduling in a mission is one of the most complicated preparations to do. It is not easy to find time to do everyone's experiment as well as the mandatory operations. What is complicated in this experiment is that ideally, the subject should not have done some physical activity shortly before the session. In the MDRS, to get to the Upper Deck from the Lower Deck you must

climb a ladder. This activity alone is enough to alter heart measurements. It was thus very complicated to have all of the crew members have a resting heart before the beginning of the session and even though 5 min of time are given in the protocol to give the heart time to rest, it is not enough to exclude all influence to the results.

To conclude, it doesn't seem like music could have negative impacts on the astronauts, on the contrary, in the few results we have, most of them seem positive. It also seems like relaxation sessions being part of an astronaut's schedule could be helpful. Given that music is cheap and extremely light, it could be interesting to test this experiment in an actual space mission and under better circumstances.

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