The Effect of Music Energy on Driving Speed

Arjun Mohunta

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Music is a core part of our everyday lives and many people like listening to music while driving. This provokes an interesting question about the effect that music has on our driving speed. A song's energy, that is its intensity and activeness, can be measured via its general entropy, onset rate, timbre, perceived loudness, and dynamic range. The current study measured the speed of drivers in various conditions: driving while listening to low-energy music, driving while listening to high-energy music, and driving without listening to music. Comparing driving speeds between conditions showed a statistically significant difference in driving speed between driving while listening to low-energy music and driving without music, but failed to prove an increase in driving speed in the high-energy music condition compared to driving without music. The results suggest that music may indeed have some effect on driving speed with driving speed corresponding to the energy of music.

Introduction

Each year approximately 1.3 million people die in road traffic crashes[1]. Considering the high prevalence of fatal road traffic injuries, determining frequent causes as well as finding ways to mitigate these causes is highly relevant. Given that many people listen to music while driving[2], investigating its impact on drivers' behaviour poses an interesting avenue in establishing factors that may foster safer driving.

As music is prevalent in our daily lives, and we often listen to music while doing our daily chores, working out, studying, playing, etc.[3], its impact on various behaviours has been of interest in past research. Herrington et al. 1996 for instance found that people's shopping behaviour in a supermarket was influenced by musical preference[4]. Further, it has been observed that tasks are done faster under fast music[5].

With regards to driving behaviour, it has been shown that music may lead to higher arousal and can thus have positive effects on driving performance as illustrated in a study by Ünal et al.2013 comparing driving in a car simulator with and without music[6]. Another study investigating effects of music on driving behaviour concluded that listening to music impacts an individual's mood which in turn affects their driving behaviour[7]. Further, Babić et al. 2021 observed that different genres of music may influence drivers differently: Drivers' average speed increased to around 60 km/h when they were made to listen to Balkan folk and metal music compared to an average speed of 50 km/h when listening to other music genres or no music at all[8]. Specifically looking at the effect of music energy, van der Zwaag et al. 2011 found that anger induction during driving in a driving simulator was highest for high-energy negative-valence music[9].

Not only do many people listen to music in their everyday life for simple pleasure or distraction, but nowadays, music is also being used as a therapy to reduce stress and improve the well-being of people[10], and to facilitate relaxation of the body[11]. Considering that stress has been shown to lead to dangerous driving behaviour[12], the stress-reducing qualities of music might be beneficial for encouraging safer driving.

Based on this, I hypothesised that listening to music as an effective tool for stress reduction may also have beneficial effects on driving behaviour. Therefore this paper measures people's response to music while driving. Specifically, the effect of music energy on driving speed is investigated. Music energy is measured as a song's general entropy, onset rate, timbre, perceived loudness, and dynamic range.

As reviewed above, some experiments have been conducted to test the effect of music on people's driving behaviour in different conditions, all of which have brought a variety of information to the table. However, most of these studies have been done using driving simulators rather than testing the effects of music in an ecologically valid environment. Hence, my study will look at driving in the natural environment. Moreover, while effects have been found, their underlying mechanisms remain unclear. Therefore, in this paper, qualitative interviews were conducted with the drivers in order to complement analyses of quantitative driving measures.

Methods

Participants

The data used in this experiment were collected via a random convenience sampling. Drivers were randomly approached in two Indian cities, Chandigarh and Panchkula, asking if they would be willing to participate in an experiment. Data

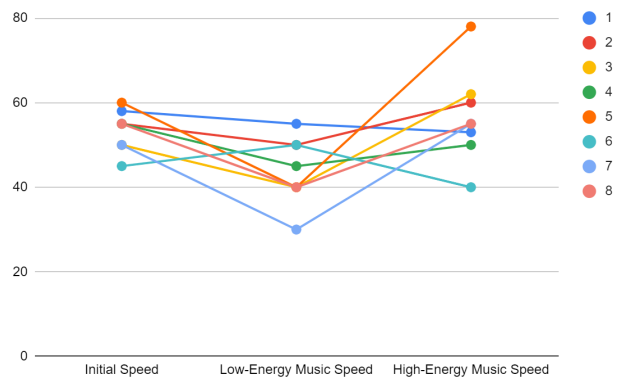

Fig. 1 Initial driving speed, driving speed under low-energy music, and driving speed under high-energy music in km/h. Each coloured dot represents an individual participant.

were collected at different times of the day. The sample included four male and four female participants. Participants' age ranged from 35 to 65 and their mean age was 45 years.

Procedure

Drivers who agreed to participate were asked to fill in an informed consent form. Following this, the experiment consisted of three stages: in the first step, no music was played and the driver was asked to drive the car like they normally would for a period of five minutes; then, in the second step, low-energy music ("Agar tum saath ho", energy score of 52 out of 100 on Tunebat) was played in the background for a period of five minutes; in the third step, high-energy music ("Jai jai shivshankar", energy score of 90 out of 100 on Tunebat) was played for a final period of five minutes. The music chosen by the researcher was lyrical Bollywood music which the drivers confirmed was familiar to them and the songs chosen remained the same for every driver. Drivers were tested in different environments: Two drivers were asked to drive on empty roads without any lights or traffic, another two drivers drove along a curvy road without much traffic, and the final two drivers drove along a road with some lights and medium traffic. The drivers were constantly monitored on their driving speed and their average speed in km/hr was noted with the help of a speedometer on Google Maps. At last, the drivers were asked to give qualitative feedback about how they felt their driving speed had been influenced.

Analysis

As the experiment was carried out as a within-subjects-design (every participant underwent all three driving conditions) trying to assess the effect of three music conditions on driving speed, a repeated-measures ANOVA would be an appropriate test for the current dataset in order to assess the overall effect of music on driving speed. However, given the small sample size, a Friedman test will be carried out instead. The Friedman test can be used as a non-parametric alternative to the ANOVA. In doing the Friedman test, the data is rank-ordered to test differences between groups rather than relying on means and variances to calculate test statistics which can be problematic if underlying distribution assumptions are violated. If the Friedman test gives a significant result, a Conover test will be calculated to do post-hoc pairwise comparisons between the three music conditions. Qualitative interview data was compared between participants who did or did not show an effect of music on their driving speed and common themes were identified.

Results

The main hypotheses presented in this experiment were that when low-energy music is played then the car speed would slow down and when high-energy music is played then the car speed would increase. To test these hypotheses, a Friedman test followed by a Conover test for post-hoc pairwise comparisons was conducted. In line with the first hypothesis, an overall effect of music on driving speed was found as indicated by a significant result in the Friedman test ($X^2(2,8) = 4.84, p < 0.10$). The Conover test results revealed that there was a significant difference between participants' initial driving speed without music ($mean = 53.5, SD = 4.87$) and their driving speed while listening to low-energy music ($mean = 43.8, SD = 7.90; p < 0.05$). Contrary to the second hypothesis, there was no significant difference between initial driving speed and driving speed in the high-energy music ($mean = 56.6, SD = 10.93$) condition ($p = 0.66$). While the difference in driving speed was not significant, numerically, the trend towards faster driving while listening to high-energy music indicates some support for the second hypothesis. Moreover, comparing driving speed with high-energy music and driving speed while hearing low-energy music, a significant difference was observed ($p < 0.05$). Figure 1 shows the variation in driving speed of every individual driver tested under different circumstances (no music driving condition, driving while low-energy music is being played, and driving while high-energy music is being played).

When the participants were interviewed half of them thought that their speed was influenced by music. For instance, participant number 5 said "high-energy music made me drive fast because music influenced my mind". However, the other half of the participants thought that music did not affect their driving speed. For instance, participant number 6 said "My speed according to me remained the same". Interestingly, two of the four participants who thought they were not

Table 1 Initial Driving Speed, Driving speed in low-energy music and driving speed in high-energy music and the thoughts of participants on the influence of music on their driving speed.

Driver	Initial speed	Low-energy music speed	High-energy music speed	Interview response
1	58	55	53	Fast or low-energy music never stresses you nor makes you anxious.
2	55	50	60	Music does not affect my drive. You enjoy music on long drives and it keeps your drive smooth.
3	50	40	62	Music does matter but peace of mind matters.
4	55	45	50	The low-energy music influences especially when you are on a highway.
5	60	40	78	High-energy music made me drive fast because music influenced my mind.
6	45	50	40	My speed, according to me, remained the same.
7	50	30	55	I think the speed remained the same throughout.
8	55	40	55	It happens subconsciously that one slows the speed.

affected by the music were indeed not affected while the other two were affected pointing to an unconscious effect of music on driving speed for at least some drivers. Table 1 shows the speed observed in different situations while driving which include driving in the no music condition, driving while high-energy music is being played, and driving while low-energy music is being played.

Discussion

This study aimed to measure if low-energy music would slow drivers' speed and if high-energy music would increase drivers' speed. The hypothesis was that driving speed would decrease when listening to low-energy music and that it would increase when listening to high-energy music.. While the data collected supported a significant effect of the low-energy music on driving speed, there was no significant effect of the high-energy music. When the participants were interviewed, some realised the effect of the music on their driving speed. Others, however, came up with other explanations, such as traffic conditions, for their driving behaviour. This indicates that some drivers are conscious of the effect that music has on their driving while others may be unaware of the subtle effects of music on their behaviour.

There could be various reasons for the insignificant results in the high-energy music condition. Firstly, the order of music condition was fixed to no music followed by low-energy music followed by high-energy music. Hence, the drivers may have been more fatigued once they got to the high-energy music condition, causing them to slow their natural driving speed such that a potential speeding up effect of high-energy music may have been concealed by this counteracting effect. However, contrary to this there is also research suggesting that music may actually reduce driving fatigue [13]. Secondly, again due to the order of music conditions, drivers may have gotten the low-energy music stuck in their minds with prolonged effects on their driving speed still lasting on while in the high-energy music condition. Lastly, participants may have been conscious of being observed while driving, keeping them from speeding up even though they may have felt like driving fast while listening to high-energy music. Moreover, the small sample size of this study may have prevented finding significant results. Notably, results, while not statistically significant, were qualitatively in the expected direction with faster driving in the high-energy music condition on average. What is more, while the fact that the experiment was carried out under natural conditions is a main strength of this study, this means that external conditions such as traffic could not be controlled by the experimenter.

There are several things which can be done to improve this experiment in the future. One flaw in the study was that the order of music conditions was fixed for all participants rather than being counterbalanced. This causes an issue with interpreting the findings as driving speed may not only be influenced by the current music but also by the transition from the preceding music condition. As mentioned above, there is a trade-off between having an experiment be ecologically valid by examining driving under natural conditions versus being able to conduct an experiment in a controlled environment. Given that the study was conducted within real-world driving environments, the amount of traffic and traffic lights could not be perfectly controlled for. Comparing results between these

different approaches (e.g. observing drivers on the streets vs in a driving simulator) or finding a middle ground with testing drivers in their own cars while controlling for environmental factors as much as possible may be interesting going forwards. Moreover, collecting data from a larger sample would be desirable.

The results shown in this study can help design interventions aimed at promoting people to listen to low-energy music when driving while under stress or other conditions which may otherwise lead them to potentially dangerous speeding. While the effects of music on driving speed found in this study are very interesting, the effect on driving speed was relatively small and a number of limitations in the study design as well as a small sample size mean that further research into the effect of music energy on driving behaviour will be necessary to draw well-informed conclusions.

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