How Music of Differing Rhythmicities and Intensities Affects Driver Performance

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1. INTRODUCTION

Music has an effect on driving. Style of music has been shown to effect speed & control activity of drivers (Konz & McDougal, 1968). Volume/intensity of music has been shown to affect response times in driving-type behaviors (Beh & Hirst, 1999). Music with differing "arousal potentials" affects speed of driving (North & Hargreaves, 1999). Music has been found to affect stress levels of drivers (Wiesenthal, Hennessy, & Totten, 2000). Finally, speed, swerve, and red-light violations, all have been related to music tempo (Brodsky, 2001).

Research has shown that any sort of variation in music can affect arousal levels. Tempo (Kellaris & Kent, 1995), style (Gowensmith & Bloom, 1997), and 'musical mood' (Thompson, Schellenberg, & Husain, 2001) all have an effect on the arousal levels of listeners of music. Driving behaviors often change in different states of physiological arousal. Fatigued, and therefore less aroused drivers, tend to have more collisions, and make more driving errors then non-fatigued drivers (Dureman & Boden, 1972 & McBain 1970). People who are sleepy tend to do much worse at driving than someone who is fully alert (Dureman & Boden, 1972). It is has also been shown that too much arousal can lead to decreased performance in any task (Anderson, 1995). The concept that there is an ideal amount of arousal for optimal performance on a task is called the 'Yerkes-Dodson law.' Optimal performance occurs with intermediate levels of arousal. Music affects arousal levels and arousal levels have an effect on driving performance.

The current study examines musical intensity (volume), and rhythmicity and its impact on drivers' speed. Past research has shown that these variables do affect driver performance. No study has looked at the interaction of these variables. We expect that the variables will interact; rhythmicity should have a differing affect on driving at different intensity levels.

2. METHOD

All participants were given two questionnaires: susceptibility to simulator sickness and demographics. Participants were also given a chance to test drive the simulator.

The experiment occurred in three separate segments. Each of these segments was further divided into three zones. Road types varied from rural to highway to urban throughout the experiment.

A different music type was randomly played in each zone. This created a total of nine musical zones. After each segment of three zones, the participant was given the option of getting out of the car to stretch and get some water.
The two independent musical variables were intensity (volume) and rhythmicity. Volume was manipulated at three levels: quiet (65 dB), medium (75 dB) and loud (85 dB). Rhythmicity was also manipulated at three levels, low (50bpm; afro-Cuban percussion), medium (100bpm; rock and roll percussion) & high (200bpm; electronica percussion). The percussion track of the music was the only variation in the rhythmicity variable. The music itself stayed constant. The two manipulations created a total of nine musical variables (3 intensity by 3 rhythmicity).

The order of the music was counter balanced, so that an each of the nine musical variables occurred in each driving zone an equal number of times during the entire study. This allows us to average out the effect of differences due to road type. The differences in road type are only meant to be used as a means to increase generalizability.

Each zone took about one minute to complete. Participants were told to drive as they would normally. They were also told that if they felt uncomfortable at all during the study to exit the simulator.

3. RESULTS

The Speed data was analyzed using a 3 (volume: high, medium, low) by 3 (rhythmicity: high, medium, low) within subject's analysis of variance. Speed scores were measured by computing the average speed for each music type. Speed was measured in meters per second. The measure was again sampled three times per second. All scores of 0 m/s (i.e. the person was stopped), were removed from the data.

No significant effects or interactions were found in the original data. When the speed data was adjusted to lower variance a significant interaction was found. Variance was lowered by eliminating the differences between zones. The overall average speed was calculated (20.78 M/S). The average speed for each zone was also calculated (Z1=24.76 M/S, Z2=20.99 M/S, Z3=13.93 M/S, Z4=27.71 M/S, Z5=17.40 M/S, Z6=14.40 M/S, Z7=23.52 M/S, Z8=14.14 M/S, Z9=30.13 M/S). These zones varied tremendously due to differences in the roads themselves, not due to music differences. To eliminate this variance, each average was rounded to the nearest whole number, and the difference was found between that average and the overall average. That difference was then applied to every score from that zone. This lowered the variance between the scores due to road type, without changing the effect of music on speed. Each zone had three measures of each music type within the average. The analysis of this data is below.

The main effect of volume was not significant, $F(52,2)=1.984$, $p=0.148$. The main effect of rhythmicity was also not significant, $F(52,2)=0.704$, $p=0.499$.

The interaction between volume and rhythmicity was significant, $F(104,4)=2.93$, $p=0.024$ (Figure 1). Using simple main effects it was found that there was no difference between rhythmicity at high, $F(52,2)=2.65$, $p=0.080$, and medium, $F(52,2)=0.33$, $p=0.968$, volume levels. There was a difference in speed scores between the rhythmicity conditions only in the low intensity condition, $F(52,2)=3.707$, $p=0.031$. This difference was because there was a difference between high rhythmicity and low rhythmicity in the low volume condition, $t(26)=2.675$, $p=0.013$ (20.30 vs. 21.84). T-tests between high rhythmicity and medium rhythmicity, and medium rhythmicity and low rhythmicity were not significant, $t(26)=1.188$, $p=0.245$ and $t(26)=1.576$, $p=0.127$. In the low intensity condition rhythmicity was positively related with driver speed.

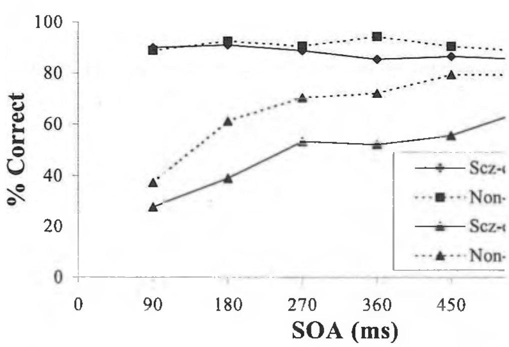

Fig. 1. Driver speed as a function of the musical rhythmicity and intensity

4. DISCUSSION

Music does affect driving. Past research, the current study, and theory point to this fact. The current study found that rhythmicity has an effect on driver speed in low intensity musical situations. This finding can be explained via driver arousal levels. Music that is louder increases arousal levels more than quieter music. In the louder musical conditions arousal levels are already maximized by musical intensity. Rhythmicity is therefore unable to increase arousal levels further. This results in no significant speed differences in the medium and high intensity conditions. In the low intensity condition (quiet), the rhythmicity is able to affect arousal levels, because the intensity does not increase arousal to its highest level. This allows rhythmicity to have an effect on driver speed.

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