
The Effects of Various Music on Angry Drivers' Subjective, Behavioral, and Physiological States

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Abstract

Emotions influence the way drivers process and react to internal or environmental factors. Specifically, anger is a serious threat on the road. While driving, a majority of drivers listen to music, which is quite an emotional stimulus. In this study, we investigated the effects of various types of music (happy, sad, and self-selected music) on angry drivers in a simulated driving. Sixty-one participants were randomly assigned in five groups: angry drivers who drove with self-selected music, angry drivers with happy music, angry drivers with sad music, angry drivers without music, and neutral drivers without music as a baseline. Three levels of outcomes (subjective, behavioral and physiological data) were analyzed. Emotion induction was successful, but no specific emotional music significantly influenced their subjective affect ratings. Angry drivers with self-selected music showed more aggressive driving behavior. Sad music increased drivers' heart rate more. Implications are discussed with emotion intervention systems.

Author Keywords

Angry driving, Emotion, Music, Aggressive Driving, Simulated Driving, Emotion Induction, Affect Regulation.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

While most driving research has mainly focused on cognition, recent research has started to reconsider emotions as a critical factor in driver distraction and safety. Emotions have a major impact on performance, regardless of whether they are processed independently of the cognitive process or not. Emotional drivers may fail to look at the right spot at the right time since their attentional resources are occupied by the demands of emotions [14]. Therefore, any unexpected changes in drivers' affective state can lead to performance errors [9]. Among all types of emotions, anger is relatively a common emotion while driving [17]. Anger can be integral or incidental to the driving experience. Integral affect describes anger which arises from first-hand experiences while driving like high traffic congestion conditions. Incidental affect comes from experiences unrelated to driving, such as events in a driver's personal life [3]. It is widely accepted in driving research that angry drivers make more driving errors than non-angry drivers [4, 11, & 17].

Research about the influence of music on driving has shown contradictory results [8]. Some studies found that the presence of music while completing a task might contribute to cognitive overload due to additional irrelevant stimuli, especially when there are not enough available cognitive resources to attend all the demands of the task [16].

In contrast, it is also found that listening to music does not negatively influence driving performance [7], but can even facilitate safer driving [1]. It seems that the potential effects of listening to music while driving are moderated by workload levels. If a driving task is very demanding, listening to music may deteriorate driving performance. However, in an unchallenging driving environment, music may not influence task performance at all or even enhance driving

performance in some cases [1, 18, & 19]. Music is inherently emotional, but there is little research on the effects of music on emotional drivers. This study addresses this issue.

Since human capacity is limited [13], drivers' performance may deteriorate by the emotion independent of or by influencing on cognitive processes [18]. Lerner and Tiedens (2006) in their Appraisal-Tendency Framework (ATF) stated that specific emotions create specific cognitive properties that may represent at the biological and behavioral levels. Their research showed that angry people tend to be more optimistic when negative outcomes are de-emphasized and they also blame other individuals more for negative outcomes [15]. Thus, they may not be careful on the road. This offers a potential explanation on aggressive driving of angry drivers.

The gaps and contradictory results of previous studies show that the effects of music on driving task depend on the type of music and the demands of the primary task. With the low task demand, music can mitigate emotional driving by serving as a "positive" distractor, in which it occupies a small portion of cognitive resources. This notion is close to the emotion regulation strategy, attentional deployment [12]. In fact, Jeon (2012) showed that simple speech-based interventions (as attention deployment) helped angry drivers successfully divert drivers' attention from their anger to the driving environment. To examine the relationship between various types of music and angry driving, we designed a simulated driving experiment with an emotion induction method. To disentangle this interaction in a more holistic way, we explored three levels of driver data – subjective, behavioral, and physiological.

Method Participants

Sixty-one undergraduate students ($M = 45$, $F = 16$, $M = 19.9$, $SD = 3.6$) were randomly assigned to five groups: angry drivers who drove with self-selected

music = 13, angry drivers who drove with happy music = 12, angry drivers who drove with sad music = 12, angry drivers who drove without listening to any music = 14, & neutral drivers who drove without listening to any music = 10. All the participants were recruited from Michigan Technological University through the online recruitment system for partial course credits and had at least 1.5 years of driving experience.

Apparatus

Driving simulator: The driving simulator consisted of SimuRide software running on a Dell Optiplex 960 using Windows 7 operating system. The monitor was a 39" Samsung LED TV placed on a desk in front of the participant. A Logitech G27 USB steering wheel and gas/brake pedals were used to better simulate real world driving.

Electrocardiogram (ECG): To measure heartrate, we used Equivital. Its LifeMonitor is a body worn sensor which records data every.2 second.

Music Stimuli

In a pilot study, we validated emotions of four songs. Ten participants (who did not participate in the actual experiment) listened to ten musical stimuli and rated those based on types of emotion they attribute to them on a seven point Likert scale. Two happy songs (Monsieur Verdoux: Cancan a Paris Boulevard and Op.77-3rd Movement: Vivace Non Troppo) and two sad songs (Madeleine and Carlotta's Portrait and Brothers-Backdraft) were selected for the experiment.

Design and Procedure

After completing the consent procedure, participants were asked to rate their current affective states using a seven point Likert scale measuring 9 discrete driving-

related emotions [10, 11]. Participants were allowed 5 minutes to practice driving in a different scenario to get the controls. Following the practice session, participants in the four conditions (self-selected, happy, sad, and no-music) spent twelve minutes writing about an angry experience they could vividly remember [10]. After the mood induction procedure, they rated their emotion check survey for the second time. Drivers in the control group wrote about a neutral daily activity and rated their emotion after the 12 minutes writing. Next, drivers in the self-selected music had two minutes to pick a music piece from YouTube or cellphone playlist. This music played on repeat during their drive in the experimental scenario. Participants in the no-music condition did not listen to any music when they drove in the experimental scenario. Drivers in the happy and sad music conditions listened to the experimenter-selected happy and sad music that were validated in the pilot study. The experimental driving scenario consisted of three difficulty levels: easy (highway), medium (rural road), and hard (foggy and snowy road). Participants were instructed to continue straight at all intersections, and turn right only when continuing straight is not an option. The driving portion lasted approximately fifteen minutes and was observed by the experimenter for common anger-related driving errors, such as lane departure, speeding, aggressive accelerating/braking, violating traffic rules, and collisions [5, 14].

Results

There were minimum cases for violating traffic rules and collisions and so no further analysis was conducted for them.

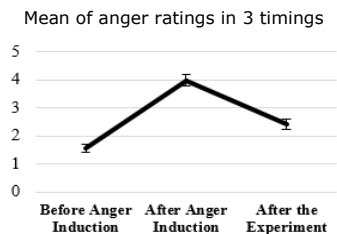


Figure 1 Mean of anger ratings in 3 timings. Error bars indicate standard error of the mean "conditions".

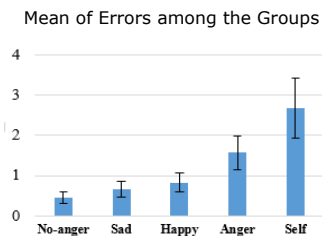


Figure 2 Mean of aggressive driving errors across conditions. Error bars indicate standard error of the mean.

Subjective Data

Results from the self-report questionnaire showed that we successfully induced anger in the intended four groups (except for the control group). Forty-two participants out of 51 (82%) indicated that they got angry (see Figure 1) by the writing exercise. Paired samples t-tests showed that anger scores after affect induction ($M = 3.98$, $SD = 1.48$) were significantly higher than before induction ($M = 1.56$, $SD = 1.06$), $t(50) = -10.5$, $p < .001$. The data of nine participants that did not indicate an increase in anger on the subjective measure after mood induction were also included in the analysis because they might not consciously notice the changes of their affective state. We also checked anger-induced participants' affective state at the end of the experiment. Paired samples t-tests showed that anger scores at the end of the experiment ($M = 2.41$, $SD = 1.41$) were significantly lower than after affect induction ($M = 3.98$, $SD = 1.48$), $t(50) = 8.06$, $p < .001$, which means their level of anger decreased during the experiment but still was significantly higher than when they came to the lab, $t(50) = -4.28$, $p < .001$.

The pattern of increasing and decreasing anger scores were similar in each of the four groups. To see whether a specific type of music (happy, sad, and self-selected) contributed more to decreasing drivers' angry level, a one-way ANOVA was performed. In this comparison, the scores of angry level at the end of the experiment were subtracted from the scores of after emotion induction. The results show that there is not any significant difference among the groups, $F(3, 47) = .64$, $p > .05$.

Behavioral Data

Separate one-way analyses of variance (ANOVA) were performed to investigate the effects of music on driving performance.

Lane Departure: One-way ANOVA showed that results of lane departure were not different among the five groups, $F(4, 58) = .91$, $p > .05$.

Speeding: One-way ANOVA showed that results of speeding were not different among the groups $F(4, 57) = 1.03$, $p > .05$.

Aggressive Driving: Aggressive accelerating and braking was checked by the signal of energy efficient use of vehicles [11]. Results of one-way ANOVA showed that the total errors among the groups were not significantly different from each other $F(4, 57) = .38$, $p > .05$.

However, a closer look revealed the significant differences when considering the difficulty level of road conditions. Results of one-way ANOVA showed that aggressive driving behaviors were not different among groups in easy $F(4, 57) = .78$, $p > .05$ and medium $F(4, 57) = 1.79$, $p > .05$ conditions; but in the hard condition $F(4, 57) = 5.28$, $p < .005$, there were significant differences. Tukey HSD tests showed that drivers who drove with self-selected music ($M = 2.69$) had significantly more errors than the groups who drove with sad music ($M = .66$, $p < .01$), happy music ($M = .83$, $p < .01$), and the control group ($M = .45$, $p < .01$) (Figure 2).

Physiological Data

The difference in driver mean heartrate between the practice session and the driving session was compared. The results of one-way ANOVA showed significant differences between conditions $F(4, 45) = 3.75$, $p < .05$. Post hoc analysis with Tukey HSD tests showed

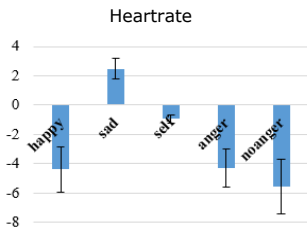


Figure 3 Changes in heartrate between practice and driving sessions. Error bars indicate standard error of the mean.

that the increase of drivers' heartrate in the sad music condition ($M = 2.46$) was significantly different from the decrease of heartrate among the angry drivers who did not listen to any music ($M = -4.29$), $p < .05$, who listened to happy music ($M = -4.38$), $p < .05$, and drivers in the control group ($M = 2.46$), $p < .01$ (Figure 3).

Discussion and Conclusion

Angry drivers and road rage have been considered critical safety concerns [e.g., 14] and researchers have been looking for coping strategies to tackle this issue. Since drivers' vision is heavily occupied, music and auditory displays can serve as an effective intervention technique. To see the impacts of different types of music on angry driving, we analyzed drivers' subjective, behavioral, and physiological states using the simulated driving environment.

The results from the self-report questionnaire showed that writing the past experience successfully induced anger. Unexpectedly, any specific music did not play a more role to reduce participants' angry level. We obtained their subjective response at the same time (only after the experiment). It would be interesting if we could compare the timing when the angry state went down in each group. With regard to the driving behavior, drivers who listened to self-selected music accelerated and braked more aggressively than those who drove with sad and happy music as well as the control group. We cautiously infer that happy and sad music helped angry drivers reduce their aggressive driving to the level of emotionally neutral drivers, but self-selected music might exaggerate aggressive behavioral tendencies – harder accelerating and braking. There might be two possible explanations for this result. First, angry drivers who listened to self-

selected music might have chosen music that is congruent with their mood, which may strengthen their angry state and lead to increased aggressive behaviors. Alternatively, the result might not be related to their anger, but to the fact that they listened to self-selected music, which is more familiar and more emotionally attached. This familiar music could be more distracting than unfamiliar music, and could slow reaction time to recognize objects or prepare for the situations on the road. Preliminary analysis of song selections suggests that angry drivers did not choose mood-congruent music. Instead, they categorized their music as happy (25%) and relieved (25%) more than any other type. In line with previous research, this difference only appeared in the hard difficulty level. Thus, the implication is that self-selected music might negatively impact angry drivers in the demanding road condition, whereas unfamiliar music might not. Further studies need to be done to confirm this hypothesis. On the physiological level, the heartrate pattern was measured in each group. Findings of heartrate changes while driving before and after emotion induction and while listening to music revealed that, sad music increased drivers' heartrate significantly more than drivers who listened to happy music and those who did not listen to music. Sadness of music and drivers' anger might interact in a negative way and boost up drivers' emotional gage. Alternatively, we can think of the possibility that sad music might add more workload to drivers as their increased heartrate indicated. This also needs further investigation.

The results of this study will help us find emotion regulation strategies to design systems for road users' safety. The limitations of the present study includes emotion induction in the lab setting and use of the low fidelity simulator. To obtain more reliable and

generalizable data, we will include emotion-inducing road scenarios in a higher fidelity simulator with more physiological sensors in the next study.

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