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**Research Article**

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# A Summary of the Relationship between Driving Behavior and Emotions

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**Abstract** This paper combs through the articles on driving behavior and emotions in recent years, first introduces the understanding and analysis of emotions in psychology, and then divides the article on the relationship between driving behavior and emotions into two categories, the first is the influence of emotion on driving behavior, and the second is the influence of driving behavior on emotions. Secondly, it explains and analyzes in detail how behavior affects emotions and what emotions they produce, and why they occur. Finally, it is concluded that negative driving behavior can change physiological indicators such as the driver's heart rate and produce feelings of anger, anxiety and so on.

**Keywords** driving behavior; emotions

## 1. Introduction

In psychology, behavior is the activity produced by organisms under the influence of various internal and external stimuli. Emotion is a kind of psychological phenomenon which is mediated by the subject's needs, wishes and other tendencies. Emotions always depend on the interaction between people and the environment. Behavior can affect emotions in two ways. First, certain behaviors have a direct impact on improving mood. Second, certain behaviors indirectly affect our emotional ways through their role in cognition.

## 2. Research on emotions in the field of transportation

In the field of transportation, most studies of emotions are based on emotional influence behavior, and the method of study is generally to determine the interference of emotions with behavior by developing programs to stimulate emotions. For example, anger.

Anger is generally an enhanced emotional state expressed by a person or animal's dissatisfaction with itself and the outside world, and psychological research shows that this emotional state will have a certain effect on an individual's sense of behavior. When a driver is in a state of anger, his driving behavior will deviate from the norm, thus affecting traffic safety. There is a general consensus that anger increases the likelihood of aggressive driving. The more common effects of anger on driving control behavior include driving speed, braking frequency, shift frequency, siren, zebra crossing deceleration, etc., and it can not directly determine that all the effects are not conducive to traffic safety, the nature of its role is still unclear, which is one of the reasons why the relationship between anger and driving behavior is controversial. In the current study of emotions, some scholars believe that the traditional method underestimates the process and relationship of emotions, emotions can be understood as dynamic, the whole emotional process, reflecting the whole process of individual psychological game persistence. Emotions usually last longer, which is one of the obvious characteristics of emotional experience, and even when viewed dynamically, changes in emotional quality are often interpreted as an indicator of how one emotion translates into another, rather than as part of a time-extended plot.

Questionnaires are often used during the data collection phase to perform different analyses based on different populations. In data analysis, some methods of probability theory are mainly used, such as card-side testing, variance analysis, and Spearman rank correlation. During the data collection phase, questionnaires can be used

to collect information, such as how to stimulate anger and how to quantify it, based on cognitive behavior, and how to reduce it. And there is a strong connection with the driver's own personality, but intervention can reduce the risk. During the experimental phase, other disciplines can be tried to implement interventions when anger or other disturbances in driving behavior occur, such as cognitive theory and treatment for depression development and testing in psychomedical science, or to analyze driving behavior, which is the most commonly used method in anger interventions.

Through the survey, it is found that most of the current study of emotions is still through questionnaires to collect data, and then qualitative analysis, through the probability statistics of various test methods such as variance, test, etc., the data quantified and analyzed. When studying driving behavior, many emotions can cause changes in driving behavior, not only negative effects, when emotional overexcited, the greater the impact on behavior. In designing the driver's anger induction scheme, it is shown that: anger increases the average driving speed, the effect on speeding behavior is related to specific road conditions, the effect on the number of brakes is not obvious, and the frequency of sirens is significantly increased, reducing zebra crossing deceleration to allow behavior. Although existing accident statistics show that anger is generally a negative aspect of road traffic safety, the results of the intervention show that experienced drivers are more likely to provide examples of experience-based road rage conditions as part of the intervention.

Models for emotional research include the continuity that EMRES uses to analyze emotions, and in Marco's article, the portion of the execution data collection for the model is achieved by defining the following:

1. Collect users' emotional states and preferences for songs;
2. A model that represents a song and calculates the similarity of the song.

Figure 1 shows the generic model of EMRES and the main procedural steps for getting recommendations.

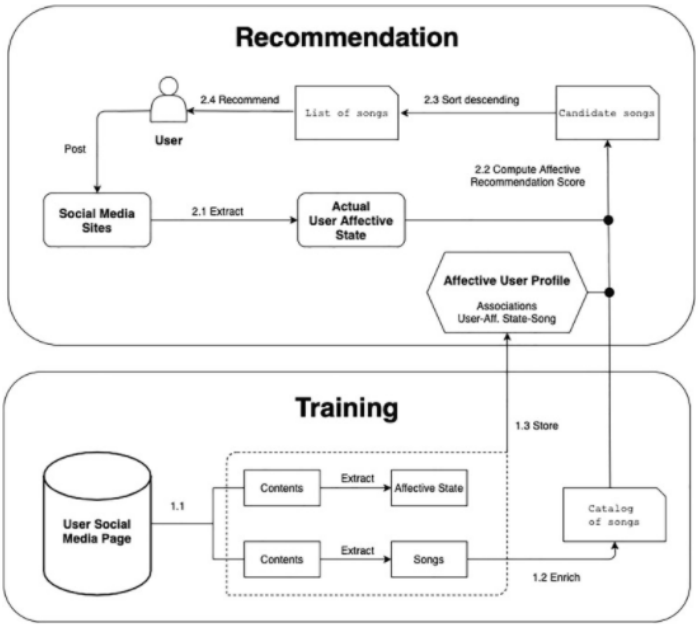


*Figure 1: A generic model of EMRES*

First of all, in the training stage, extract relevant factors from the media content, such as songs and text content, and then on the data for emotional analysis, through the lyrics to extract the user's emotional state and songs aroused emotions, the next step is to classify the user file. To detect the emotional state of user *u* at a specific time *t*, we use user *u* to post a text message W on a social media site in the time window, so that M.m1, m2,...,m,n? is a collection of *n* text messages collected in *W*. To calculate the emotional state of *u* in time *t*, n emotional vectors related to posts that fall into time window *W* are aggregated:

$$\overrightarrow{s_t} = \frac{\sum_{\delta-1}^{n} \gamma_i * \overrightarrow{m_i}}{\sum_{i=1}^{n} \gamma_i} \quad (1)$$

The exponentialattenuationfactor, i, falls into the interval of 0,1,which is used to smooth the contribution of messages away from *t:*

$$\gamma_i = 1 - e^{\frac{-\Delta T}{\tau}} \quad (2)$$

A common emotion-aware computing model based on the Emotion User Profile, where each collection of preferences is associated with the emotional state that the user felt at the time. The model calculates whether uns seeable items are suitable for the user's current emotional state by calculating the emotional consistency that takes into account both emotional user profiles and non-emotional project characteristics. This method has been implemented in the emotional-aware music recommender system, the effectiveness of which has been evaluated by in vitro experiments on two baseline data sets.

However, most of the problems in most studies, mainly samples are too small to make any conclusions about the driver subgroup according to age, gender or problem awareness, and should be further studied. Many studies have shown that the mechanism of anger is related to specific driving behavior, and that the impact on traffic safety includes both positive and negative aspects.

**3. Effects of driving behavior on mood**

In modern technology, people are also exploring the variety of tools for emotions, mobile technology and wearable sensors can provide an objective measure of psychological stress in daily life. Users can visualize and view data from sensors to increase self-awareness and facilitate adaptive coping strategies. For example, use the Mobile Life Record Platform to collect cardiovascular data from a week's real commute driving. The average driver may experience negative emotions such as anger (such as other driver behaviors) and anxiety (such as travel arrangements) on a daily basis. These negative emotions have cumulative and harmful effects on long-term cardiovascular health. For example, there is a positive correlation between traffic congestion and elevated blood pressure due to journey impedance. There are also ways to visualize emotions, such as biofeed back systems, that convert HRV data into a representation of a tree that metaphorically represents a user's health because growth patterns are affected by the user's stress state. For example, when a user is under high stress for a long time, the tree's appearance becomes more fragile. For example, many studies have used different physiological signals to determine changes in driver mood at the time, often using human-caused devices, as shown in Figure 2.

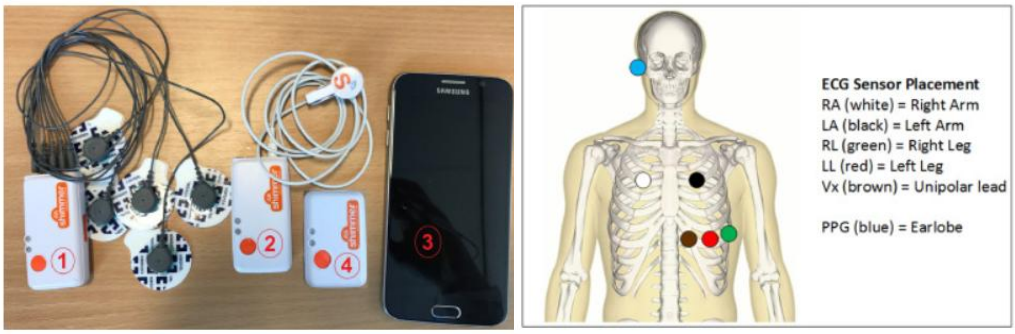


*Figure 2: Wearable Shimmer3 ™ sensor*

While aggressive driving is considered intentional, and most aggressive researchers agree that aggressive behavior is partly explained by the level of anger experienced in a given situation, some driving questionnaires designed to assess aggressive driving measure only the behavior itself and do not explicitly tap into the emotional component. In addition, whether aggressive driving merely constitutes a response to perceived violations by other drivers, or whether certain aggressive driving behaviors may be carried out without irritation and therefore may be rooted in other psychological reasons.

In the driving self-reporting literature, when establishing convergence or differentiation of effectiveness of new measures, there is a tendency to include relatively few existing self-reporting measures for driving In addition, with so many self-reporting measures in circulation, it may be difficult for some researchers to determine which questionnaires are best suited to help answer their research questions. The use of so many driving questionnaires in the literature also reduces the comparability of the results of the study because of the greater variability of specific questionnaires used between other similar studies.

## 4. Discussion

### 4.1. The kind of emotion that behavior affects

Studies have shown that more than 70% accuracy is achieved through a combination of physiology and driving characteristics plus physiology to capture negative emotions during driving, ideally, changes in anger can be inferred based solely on vehicle parameters. Physiological indicators collected from the questionnaire suggest that certain driving behaviors may cause anger, and that subjective anger experiences in real-world driving are associated with inflammatory processes at the biological level.

For example, many electrocardiogram features are extracted from the original psychophysiology data. These features include heart rate (heart rate per minute, bpm) and heart rate variability (HRV), which are measured in time and frequency domains. In the current study, PTT was used as an alternative measure of blood pressure. ECG/PPGdata segmentsa 30-secondnon-overlapping window to provide a common time base for analysis. Velocity-related descriptive statistics are also extracted from acceleration data, as well as travel times in various speed ranges, from0 to 10 mph, and calculated in10mph increments. The data were marked with change scores associated with negative emotional feelings from the anger category(S-Ang/F) of the STAXI 2 subjective questionnaire. The change score is calculated by subtracting the pre-driving response from the post-driving response for each category. Driving with a positive score is thought to indicate strong anger, while driving with a negative score indicates a low level of anger. Those who did not show a change had a score of zero.

### 4.2. How behavior affects emotions

Generating interactive data visualizations that represent cardiovascular responses in everyday life makes it easy to interpret and raise awareness of negative emotions and potential physiological activities, after visualizing data linking cardiovascular psychophysiology to interactive maps, and then linking photos and speed data to each marker through a timestamp. Interviews and inquiries with subjects found that some physiological indicators, such as blood pressure pulse, increased, but not so obviously, in congested urban roads, but they also showed the negative emotions that can be generated in driving.

Capture the front view of the road, GPS position (latitude/longitude coordinates) and vehicle speed every 30 seconds by experimenting with the experiment. The phone holder is used to place the smartphone and the camera is facing the front windshield. At the end, the device is collected from each participant and the data is downloaded to the data visualization interface. Participants were then asked to attend a data visualization meeting. Provides instructions on how to interact with data visualization, describing and demonstrating the functionality of the interface. Show participants how to use tabs to investigate different types of data and how to access maps for different journeys. They also received instructions for using the mouse to highlight icons on maps and still photos. In addition to the technical notes, participants received additional information that enabled them to understand the meaning of cardiovascular data, i.e. heart rate, autonomic nerve activation level, HRV, inflammation, PTT, blood pressure. There is no time limit for their interaction with data visualization, and participants are asked to interact with their data as long as they wish. After the participants reviewed the visualization of data from each of the three variables on the four commute, participants were interviewed about four questions: the effects of morning and evening driving, the location of high cardiovascular responses, the interface of the system, and the design of the utility. After the data visualization meeting, data collection begins in the post-test phase. The design of the post-data collection test phase is the same as described in the previous test phase. There is evidence of increased awareness of emotional triggers in the interview data and changes in psychophysiological responses during travel impedance.

### 4.3. Causes of the emotional effects of behavior

Numerous studies have shown that increased psychological workload and journey impedance in participants are two of the most common triggers for increased cardiovascular responsiveness. As a direct result of interaction with data visualization, participants experienced a decrease in heart rate and an increase in high-frequency HRV when they encountered slow-moving traffic. Specific effects on cardiovascular parameters showed that participants consciously or unconsciously changed their breathing activity during traffic jams. As a direct result of interaction with data visualization, participants experienced a decrease in heart rate and an increase in high-frequency HRV when they encountered slow-moving traffic. Specific effects on cardiovascular parameters

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Violations, verbal and physical attacks, and vehicle attacks have similar rates of variation within and between individuals, with differences of about 45% in the internal level of individuals. In contrast, errors have a variance of only about30%at the individual's internal level. Traffic emotions are the only important internal predictors of individuals and are negatively correlated with all results. All personality factors are associated with at least one dangerous driving behavior (especially extroverted and aggressive driving). And there is strong evidence that men are more likely than women to drive aggressively.

Many studies have used questionnaires to assess different aspects of driving, reflecting the diversity and complexity of driving-related emotions and behaviors that form part of the driver's subjective experience. Anger and anxiety have been found to be particularly pronounced during driving and are associated with unsafe driving behaviour. The driver may experience these emotions, or they may lead to the direct consequences of the driver's negative behavior. Behaviors measured using self-reporting have a range of intent and severity.

## 5. Conclusions

Studies have shown that, based on the general aggressive model, negative emotions act as intermediaries in the relationship between dysfunctional impulses and aggressive driving, and anger, anxiety, and happiness are associated with road events. Focusing on negative emotions, anger is primarily associated with events that impede progress, while anxiety occurs when events affect safety, and in his study, negative emotions (anger, sadness, and fear) occur twice as often as positive emotions while driving; Especially in aggressive driving incidents, anger, annoyance, threats, shock, frustration, and excitement are the emotions that drivers experience most often.

In Kovacova's study, negative emotions were seen as an emotional concept that regulates the relationship between dysfunctional impulses and aggressive driving. The results show that negative emotions regulate the relationship between dysfunctional impulses and mild aggressive driving behavior to some extent. Self-reported aggressive behavior on the road is associated with higher dysfunctional impulses and lower forgiveness. Negative emotions (anger, hostility, tension, and uneasiness) were positively correlated with aggressive driving, while internal emotions (shame and fear) were not significantly associated with aggressive driving. Negative emotions regulate the relationship between dysfunctional impulses and aggressive warnings to some extent. However, it has been shown that, in the case of provocation, dysfunctional impulses are directly related to hostile aggression and revenge, and that this relationship remains unchanged, taking into account the negative effects. The results show that the negative effects on aggressive warnings and on hostile aggression and revenge can be mitigated by forgiveness. Negative emotions can increase when a driver encounters frustration or provocation in traffic, so training on how to control impact and therefore control aggression on the road can be included in the driver education program. Interventions can also be designed to help impulsive drivers deal with situations that trigger attacks and teach them to control themselves. Strategies to promote forgiveness can be used to reduce negative emotions on the road and may therefore be effective in reducing emotionally driven aggression on the road.

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