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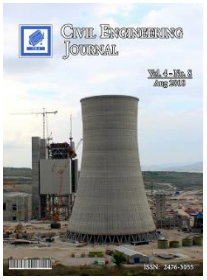

The Effect of Playing Video Advertisement Inside a Car on Driver Visual Distraction

M.R. Abhari [a], M. Tabibi [a*], F. Moghadasnejad [a], E. R. Khansari [a], E. Amini [a]

[a] *Dept. of Civil & Environmental Engineering, Amirkabir University of Technology, Tehran, Iran.*

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Abstract

With the development of in-car technologies and the use of portable devices such as tablets inside the car, one of the most interesting topics for different companies might be to promote advertising within the car. The most important issue with regard to advertising inside the vehicle is the safety issues and issues related to driver distraction. The NHTSA regulation, restricted in- car advertising in 2014, whereas, by increasing the use of in-vehicle devices and technologies, in 2016 showing video images in the vehicles were allowed under certain circumstances. The current research aims to assess the degree of visual distraction of driver caused by video advertisements broadcasted inside a car. The results of this study indicate that the type of advertisement has a direct impact on the visual distraction of the driver. In addition, findings indicate that in case of playing an advertisement in a simple form (accommodated by a speech), a safer situation might be expected compared to situations in which the same advertisement has been broadcasted by a musical content (with or without a speech).

Keywords: In-Car Advertisement; Visual Distraction; Traffic Safety.

1. Introduction

The automobile is today a comfortable and convenient means of transport that offers greater safety and significantly increased comfort for the driver and occupants of the vehicle. Particularly in the areas of safety major progress has been made through applying technological devices and ITS solutions. Since 2000, advanced in-vehicle ITS technologies have been applied in dashboard of vehicles to assist drivers while driving, among all we can address electronic brake-force distribution (EBD), lane departure warning assistant (LDWA), night vision monitoring, intelligent speed adaptation (ISA), active drive assistant (ADA) systems. Most of these systems provide a one-way relation/connection with the driver, hence, do not require the continuous attention of a driver to communicate with it, necessarily. Consequently, less negative safety impact would be expected to apply these systems [1].

Nevertheless, in vehicle manufacturing, technology developments might be taken into account as a challenge, because the number of visually demanding elements incorporated into driving tasks is increasing. In fact, increased information gathered by sensors can be useful to help improve drivers' performance, navigation and safety, however, this information may also divert the drivers' attention away from immediate driving tasks (such as keeping the lane, following the safe distance, etc.). This inadequate attention may lead to increase the chance of accidents. Additionally, much time spent looking at navigation devices might lead to unsafe driving behavior [2].

The literature review in the marketing field also indicates that third parties are eager to cooperate with car manufacturers to make added values by using the devices that already exist in cars. Among in-car devices, embedded

* Corresponding author: masuod.tabibi@gmail.com

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displays in the front dashboard have a great potential for (in-car) advertising. For instance, In the 2013 rally in the United States, the Quiznos restaurants sent coupons for drivers traveling near the restaurant to invite them coming to the (nearest) restaurant [2]. According to the literature, location-based advertisements for restaurants and other businesses, would contribute considerably in the future of in-car marketing.

Taking into account benefits explained previously for applying embedded displays in cars, the application of in-car devices, like embedded displays, can increase the chances of a driver's distraction from the main task of driving, and lead to safety reduction, similar to speaking by cellphone while driving through holding the cell phone with hands [3-5]. Facts and figures indicate that setting up the radio, cassette or CD player might be enumerated as one of the main reasons for car crashes because of distraction [6].

Similarly, touchscreens, which are used in cars, based on the contents they displayed and the various applications they can have such as routing, playing music, and radio, reading and listening to the news, can lead to mental and visual distraction for the driver [3].

The main aim of the current study is to assess the visual distraction of driver caused by video advertisements broadcasted inside a car. The study also looks for an appropriate type of advertisement to decrease the level of visual distraction to an allowable threshold.

2. Distraction: Definition, Impact, Types and Measurement

There is no a firm definition of driver's distraction, but the most relevant definition for it is the temporary deviation of the driver's attention from the main task of driving because of an issue that is unrelated to driving. These tasks, leads to reduced drivers' consciousness, increases the driver's reaction time, and consequently enhances the risk of accidents [7, 8]. Analysis of the data obtained from a study on 100 personal cars accident has shown that drivers' distraction related to performing secondary work was the reason of 48% of accidents, and 78% of accidents were caused by driver's lack of attention [9]. These statistics show the impact of distraction on traffic safety and cars' accident.

Based on the drivers' performance, distraction can be classified in two types of "visual distraction" and "cognitive distraction". These two types of distractions have much different effects on visual behavior and driver performance, and so we have to use different algorithms to recognize any of these types of distractions [10]. These two types of distractions can be described as eyes-off-road and mind-off-road [11].

Visual and cognitive distractions can occur apart or simultaneously. Visual distraction occurs when the driver's eyes look at a point other than the main view line for a certain period (usually 1 to 2 seconds to a point other than the main view line). Cognitive distraction is defined when the mind of the driver does not pay attention to the driving matter during driving. In this situation, the driver is busy to think about another problem(s) [10].

Distraction is usually measured based on algorithms which measure eyes' movements. This tool typically can be recognized as an "eye tracker". The combination of gazing and data obtained from the car and its definition in the sensory recognition algorithm can lead to the ability to detect the type of distraction (visual or cognitive distraction) [10].

In general, the higher the eyes-off-road time duration, the more the risk of the accident [12]. In addition, visual distraction can lead to inaccurate control of the vehicle, sudden response, and reaction time increase [13-15].

The National Highway Traffic Safety Administration (NHTSA) in the final edition of its guidance recommends that the in-car devices which are containing "per se lockout" should not be used in the cars. In other words, in-car devices should be designed so that drivers do not involve in any task except for driving [16].

The per se lockout category is included the text items that are automatically placed on the screen to be viewed in the desired direction (up, down, etc.). The display of books or didactic topics, the content of web pages, social media, promotional messages and text-based messages, as well as those that require manual text input for sending messages, also include "per se lockout" categories that their display in the vehicles are not recommended [16].

The United States NHTSA reports that the banned activities include the activities, which clearly affects driver performance (such as texting while driving). In addition, the activities that their bad effect has been shown on driving performance by tests are categorized as the banned activities, such as displaying the videos which are not related to driving, displaying unrelated driving images and photos, and displaying the text that moves automatically.

In 2016, the US NHTSA issued a directive entitled "Visual-Manual NHTSA Driver Distraction Guidelines for Portable and Aftermarket Devices" [13]. This guideline reflects increasing use of in-car devices in the near future, drastically. The manual has discussed the effect of in-car displays on driving safety. In this manual, car manufacturer engineers and designers of technological devices are encouraged to consider the method of interaction between the driver (human) and the machnine (namely in-car devices) [17].

In the NHTSA 2016 it is also noted that in case of using portable and aftermarket devices including per se lockout category, the driver mode for the application or software used in the devices should be considered. The driver mode should be such that the rules of the guideline are followed [2].

The investigation into the effects the technological devices such as tablets, laptops and intelligent electronic devices indicates that the impact assessment of these tools on the driver distraction has not been investigated sufficiently. However, it is a known fact that the use of these devices has a direct negative impact on driver's efficiency.

According to the NTSHA 2012 (in which any kind of video playing is banned), there is no comprehensive research about this subject. Due to this lack of research, it is impossible to compare the effect of playing a different kind of video in the car on drivers' distraction and traffic safety indexes. In the NTSHA 2016, a new approach has been proposed to measure distraction (in case of applying in-car portable and aftermarket devices (such as tablets, etc.)). In this new approach, playing video on portable devices is allowed if the device operates in the driver mode. As it was aforementioned, in this research the effect of playing video inside a car on driver visual distraction is investigated. Video advertising inside the car is interesting for a wide array of companies; to distinguish under which conditions playing an in-car advertisement on in-car displays might be allowable.

3. The Research Methodology

In the literature, four methods have been addressed to examine the driver's distraction: study at a crossroads, roadside observations, real-situation studies, and finally studies in the field of medical sciences [18].

The method of doing this research is a real-situation testing by playing advertisement with different scenarios during driving. The 7-inch Lenovo "Tab3 4G Dual SIM 16GB Tablet" has been used to play the ads. The tablet was mounted in the middle of the car dashboard with a tablet holder. The position of the tablet is shown in Figure 1.

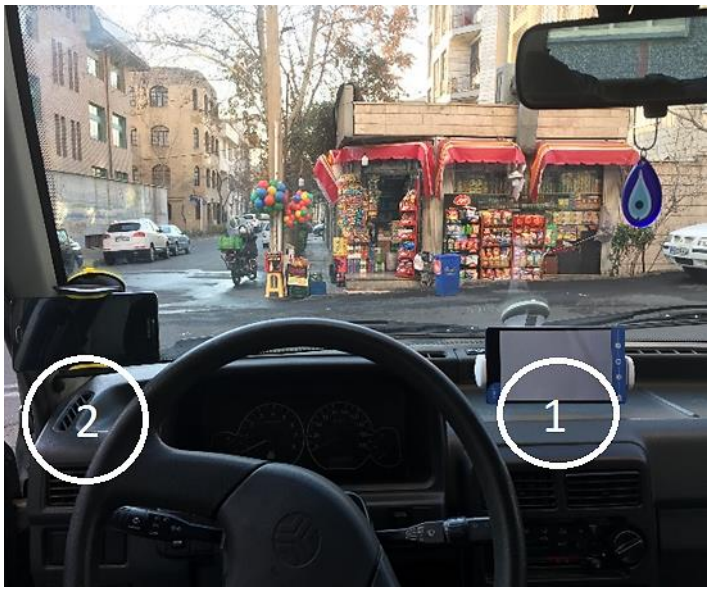


Figure 1. The tablet inserted in the middle of the car dashboard (Number 1). The cellphone in the left of the car windscreen (Number 2) was used to record drivers' face.

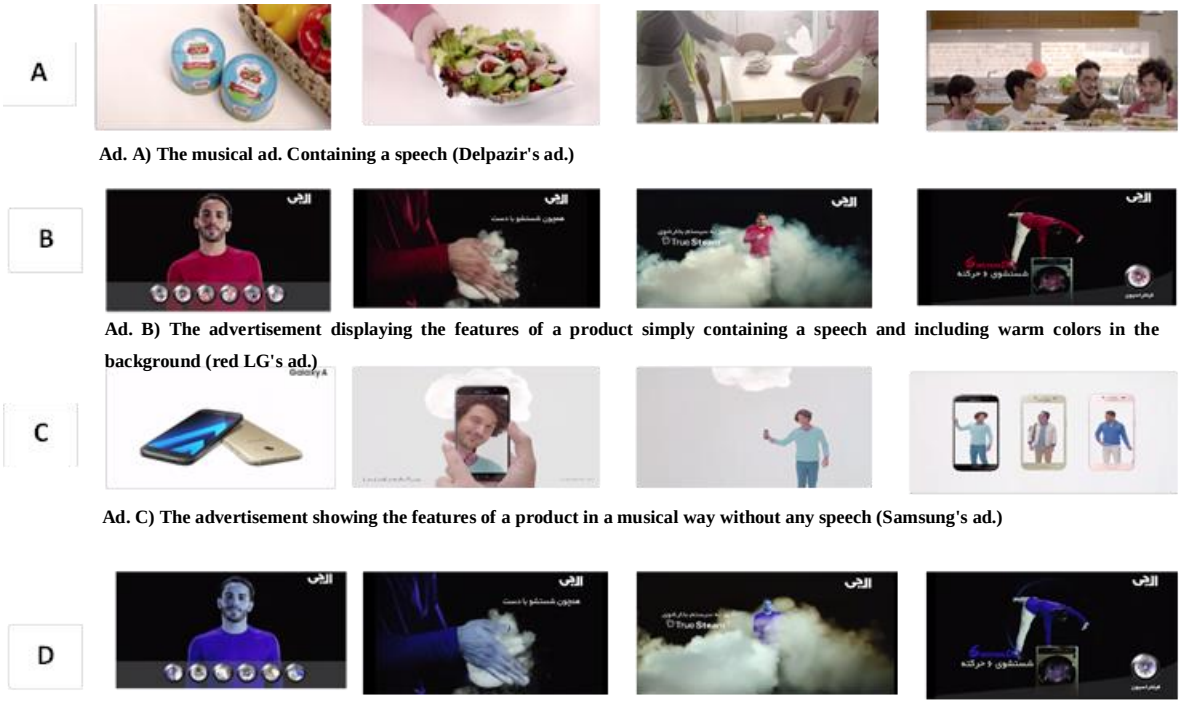
3.1. Participants

All participants enrolled voluntarily. There was no specific limitation for participants except for existing the driving license. 32 persons were involved as participants (8 women and 24 men). The participants' age varies between 22 up to 64 years with an average of 31.8. The average of the driving period (the time since they had taken their driving license) has been 14.3 years with the lower and upper threshold of 2.5 to 45 years.

3.2. Advertising Scenarios

The advertisements, which have been playing in Iranian national television, are used, as the film scenarios, in this study. These advertisements had not been broadcasted on television over the past three months before holding the test. With this practice, drivers could not remember the advertisements due to long time passing from playing the advertisement in the national TV during the last three months. The musical ads are the ones that their messages are displayed with the music and rhythm. Advertising displays the technical characteristics of a product, a method of work of goods or services which are presented.

In this study, 4 ads with different scenarios have been compared with each other. The advertisement scenarios have been as follow:



Ad. A) The musical ad. Containing a speech (Delpazir's ad.)

Ad. B) The advertisement displaying the features of a product simply containing a speech and including warm colors in the background (red LG's ad.)

Ad. C) The advertisement showing the features of a product in a musical way without any speech (Samsung's ad.)

Ad. D) The advertisement displaying the features of a product simply containing a speech and including cool colors in the background (blue LG's ad.)

Figure 2. Snapshots of 4 types of advertisements have been playing in cars

3.3. Driving Route Spec to Achieve Tests

One of the main motorways of Tehran in Iran (named as the Hemmat separated Expressway), including 3 lanes at each direction, was chosen as a driving route. The tests were performed at the time in which the level of service (LOS) has been B, approximately. These characteristics are in accordance with the rolls stated at NHTSA for distraction tests.

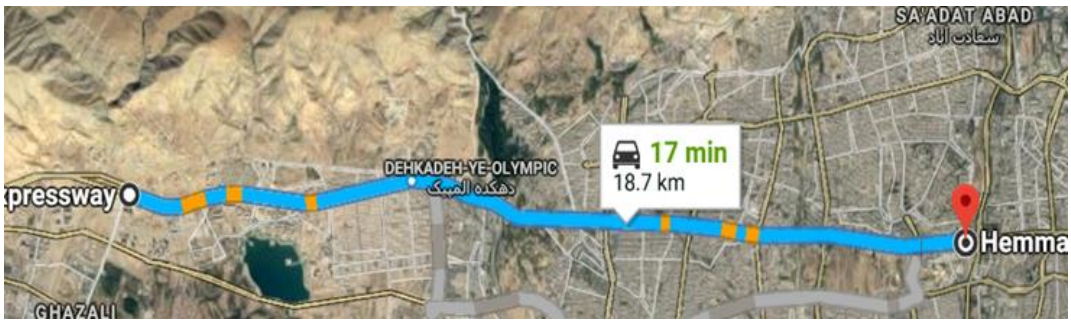


Figure 3. Driving route

3.4. The experiment Process

Before starting the experiment the tablet has been installed at the mentioned position. Then, as shown in the Figure 1, a cell phone has been installed to the left side of the car windscreen to record the films driven from the driver's face. The cell phone has been installed in such a way that it did not disturb the driver's view. The drivers were asked to drive along the motorway about 10 minutes to get used to driving with the installed devices in the car. Normally, the required time for driver warming (to be sure about her/his normal driving skills) has been reported about 2 to 5 minutes [1, 19, 20]. In this study, adaptation time was considered 10 minutes to be sure that the drivers get used to additional devices, too. In this period, the tablet was off, but the cell phone has been recording the film.

After 10 minutes (from the start time of the experiment), ads. were playing respectively; starting with the state “ad. A” ending with the state “ad. D” in a 30-seconds time interval. Simultaneously, the recording of the drivers’ face was

performing by the installed cell phone. Passing 30 seconds since playing the last advertisement, similar cycles have been performed repeatedly.

To neglect the impact of broadcasting sequence, each ad. has been played (at least) 4 times and the average of four times broadcasting has been presented for off-road glances variables (number of off-road glances, a total of off-road glance duration, mean of off-road glances and off-road glances longer than 2 seconds).

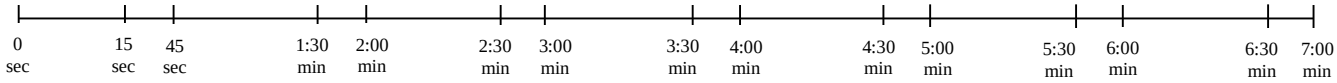
Since the initial playing advertisement may affect the distraction impact of the three next advertisements, to assess the real relative impact of 4 aforementioned scenarios of advertisements on the driver distraction, at first, two other advertisements (with unrelated subjects- compared to the main 4 scenarios) have been playing. Following these two unrelated advertisements, the playing of the 4 main advertisements have been put in the agenda.

By performing each scenario, the number of times in which the driver has been distracted from the main road, and also the time duration for such a deviation have been measured (for each ad.).

To validate this data, the data for drivers' distortion has been gathered in another way. Each movie has been fragmented into different frames (with the help of MATLAB software modules). Then, the start and the end frames of each recognized distraction has been registered manually. Taken into account the recording in 10 frames per seconds (FPS) state, the total duration time of the driver's eyes-off-road can be measured. By comparing the data obtained from the image processing and that obtained manually, it was observed that due to poor light conditions and also camera shaking/vibrations, the data obtained from the automatic image processing has had larger errors. That is a reason why the manual data was used as a more accurate method to gather the real data.

Table 1. Advertising timeline

Showing intro image containing a music	30 sec	Ad. 1 Playing First irrelated ad.	30 sec	Ad. 2 Playing second irrelated tested.	30 sec	Playing advertisement A (30 sec)	30 sec	Playing advertisement B (30 sec)	30 sec	Playing advertisement C (30 sec)	30 sec	Playing advertisement D (30 sec)	30 sec



4. Data Analysis

In this study, the independent variables are different types of ads (4 types). Also, the number of off-road glances, total of off-road glance duration, mean of off-road glances and off-road glances longer than 2 seconds are classified as dependent variables [12].

5. Results

Impact analysis of the type of advertising on the "number of off-road glances", "the total off-road glance duration", "mean off-road glances" and finally "number of off-road glances longer than 2 seconds" has been measured by using the ANOVA method. As it was mentioned, in this study the type of advertising has been considered as an independent variable. Accordingly, our independent variables are: musical ads with speech (Ad. “A”), Advertisement of a product simply and spoken, including warm colors in the background (Ad. “B”), A musical advertisement about a product without any speech (Ad. “C”), Advertisement of a product in a simple form, spoken, with cool colors in the background (Ad. “D”).

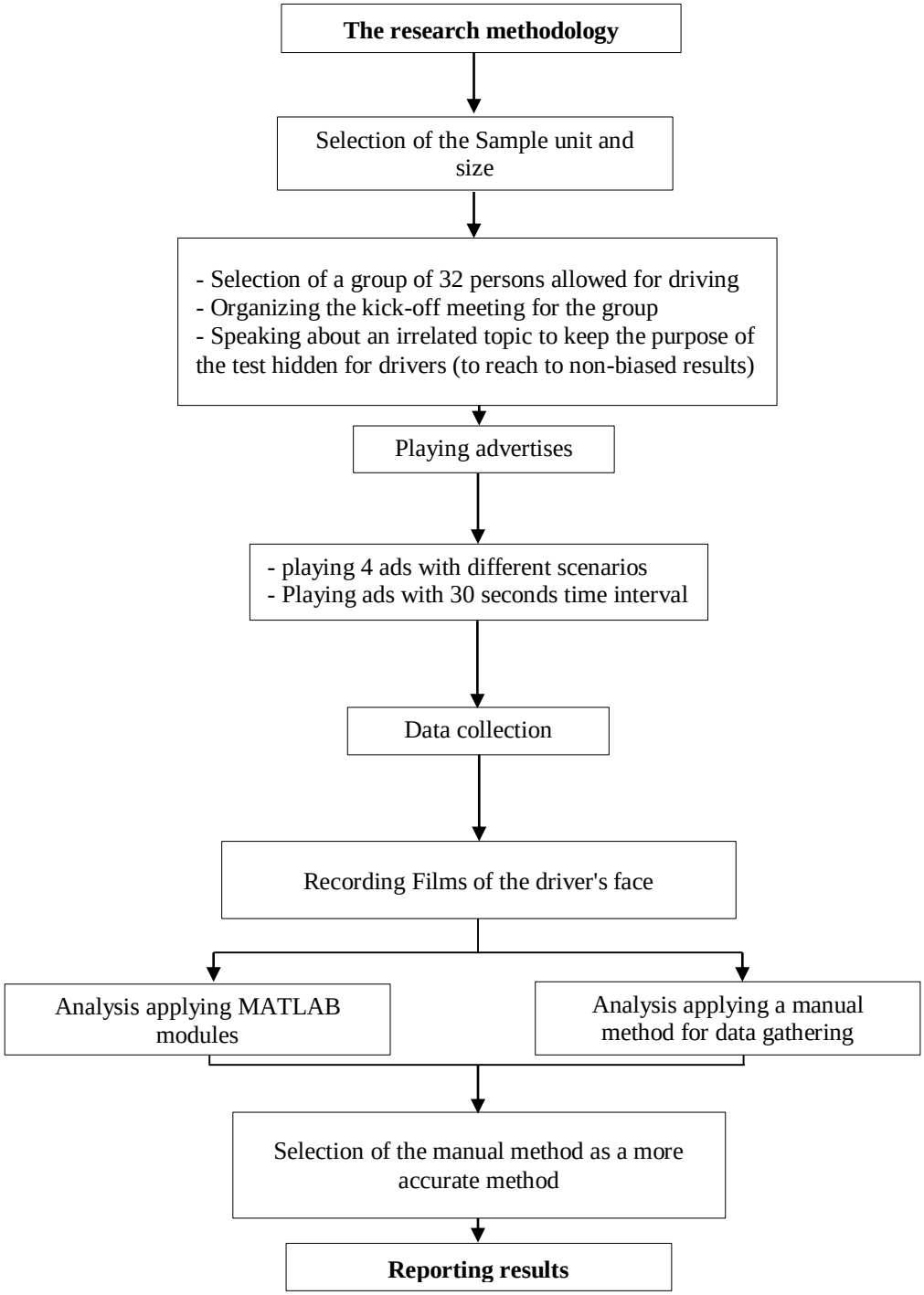


Figure 4. The methodological framework of the research

The results obtained from the Repeated ANOVA test indicated that the type of advertising has a significant effect on the "number of off-road glances" (sig =0.000<0.05, F=27.96). Ad 'A' has more "number of off-road glances" in comparison with other ads, and ad 'C' has more "number of off-road glances" in comparison with ads 'B' and 'D'.In addition, the total of Off-Road Glance Duration varies from one to the other (sig =0.000<0.05, F=19.48). Ad 'A' has more "the total of off-road glances" in comparison with 'C' and 'D', and ad 'C' has more "the total of off-road glances" in comparison with ads 'B' and 'D'.

Also, the results show that the type of advertisement has a significant effect on "mean off-road glances" (sig=0.000<0.05, F=16.94). Data findings indicate that Ad 'A' has more "mean off-road glances" in comparison with 'C' and 'D', and ad 'C' has more "mean off-road glances" in comparison with ads 'B' and 'D'.

Moreover, findings reflect that there is not a meaningful difference in the number of Off-Road Glances longer than 2 seconds in different advertisements (sig=0.113, F=2.53). Figure 5 reflects the variation of variables in all four types of advertisements.

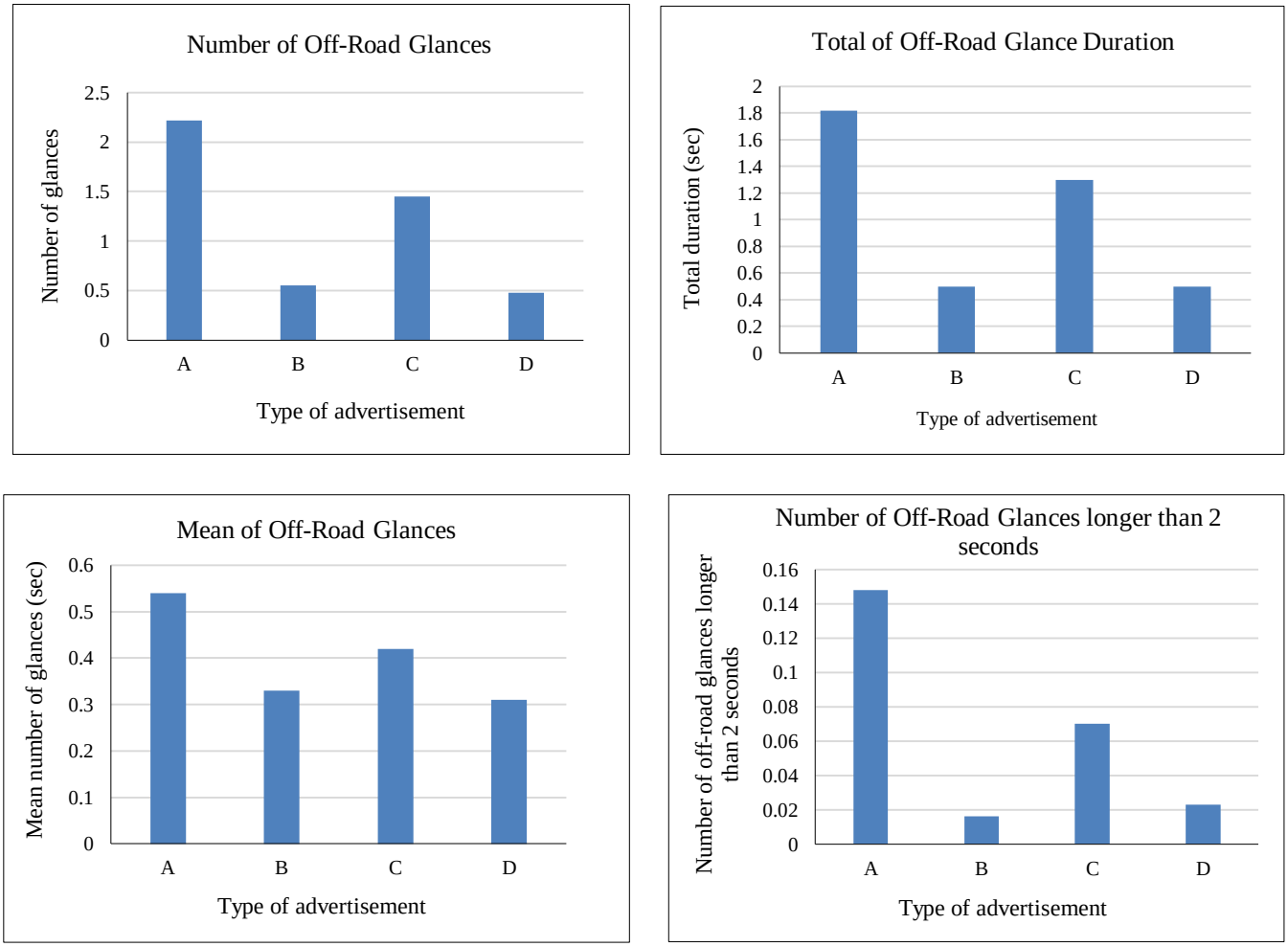


Figure 5. The relationships between different kind of advertisements and off-road glances

6. Discussion

According to the results of the repeated ANOVA test, the "number of off-road glances" at musical Ad. with the speech (Delpazir Ad.), has a major difference with other ads (sig<0.05). In addition, the "total of off-road glance duration" and the "mean of off-road glances" in the musical Ad. with speech (Delpazir Ad.) has a dramatic difference with the simple ads (sig<0.05). Also, advertise showing the features of a product in a musical way without speech (Samsung) had a big difference with other ads in the "number of off-road glances", "total of off-road glance duration" and the "mean of off-road glances" (sig<0.05).

Advertise displaying the features of a product simply and spoken, with warm colors as the background and advertise displaying the features of a product simply and spoken, with cool colors as the background did not significantly differ in visually distracting parameters. "number of off-road glances longer than 2 seconds" was not much difference in any of the ads.

From the results obtained from the repeated ANOVA test, it can be concluded that the type of advertisement played inside the vehicle has a significant effect on the "number of off-road glances", the "total of off-road glance duration" and the "mean of off-road glances".

It was also found that musical ad with speech (ad. "A") led to a more visual distraction, as it increases both the number and , duration time by which the driver look out of the road (view line) compared to advertisements paying attention more in detail about a specific product. On this basis, it can be concluded that advertisements in form of "ads. C and D" who describe the characteristics of a product might reflect a better result compared to the musical ad with a speech.

In case of advertises displaying the features of a product, three types of advertisements have been examined. In the ANOVA test, there was a significant difference between advertising showing the features of a product in a musical way

and without a speech with two other simple cases (sig<0.05). It shows that advertisements who has been displaying the features of a product simply, are the better choice for in-car advertising.

While driving, the "number of off-road glances longer than 2 seconds", increases the chance of a collision to double [7]. According to the results, there was no significant difference in the "number of off-road glances longer than 2 seconds" in different advertisements (sig=0.113, F=2.53). The advertisements displaying the features of a product simply and spoken have less value than the other two. In this regard, we can have a more positive look at using this type of in-car advertisement.

To carry out this study, there were some limitations on the conditions for participants. In the case of testing more people, driving in different atmospheric conditions, as well as assessing the performance of the drivers (such as an average of speed and headway) can make a better view over the effect of advertisements on driving behavior as well as a distraction.

7. Conclusion

In this research, by playing four kinds of advertisements (with different scenarios) inside the car and evaluating the drivers' eyes-off-road distraction, it was concluded that the kind of advertisement played inside the car has a great effect on the "number of off-road glances", "the total off-road glance duration" and "mean off-road glances". In addition, according to the results of repeated ANOVA test, the following conclusions were obtained.

- The type of advertisement has been playing inside the vehicle has a significant impact on drivers' distraction.
- Musical advertising with a speech might lead to higher visual distraction by the driver.
- For in-car advertisements, advertises displaying the features of a product simply is more suitable for advertising than musical ads.
- The advertises displaying the features of a product simply have less risk of visual distraction (looking more than 2 seconds out of the road), and the number of times duration and the mean number of the look was less than the rest of the advertisements that could be looked more positive. In another word, this type of advertisement is more suitable for playing inside the car.

For playing advertisement inside the car, the main concern is drivers' visual distraction and this research shows the musical ad with speech might lead to a higher extent of the instruction.

There were some limitations in different parts of this research such as small sample size of participants, the tests' condition, and selection of participants. To achieve better results, this test should do on a larger group of participants and in the different kinds of road condition as well as different weather situation.

A research can be done in this field could be investigating the methods that reduce drivers visual distraction due to playing ads inside the cars.

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