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BEDRIJFSECONOMISCHE WETENSCHAPPEN

master in de verkeerskunde: verkeersveiligheid
(Interfacultaire opleiding)

Masterproef

Measuring the impact of digital information displays on speed: a driving simulator study

Promotor :
Prof. dr. Gerhard WETS

Copromotor :
dr. Kris BRIJS

Joris Cornu

Masterproef voorgedragen tot het bekomen van de graad van master in de verkeerskunde , afstudeerrichting verkeersveiligheid

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MEASURING THE IMPACT OF DIGITAL INFORMATION DISPLAYS ON SPEED: A DRIVING SIMULATOR STUDY

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ABSTRACT

Speeding is a major problem in today's society and contributes to 30 percent of all fatal accidents. The primary objective of this study is to examine the impact of digital information displays on driving behavior at 70 km/h to 50 km/h transition zones. Therefore, two real world locations with a high percentage of speeding violations are rebuilt as realistic as possible in a driving simulator. Sixty-six participants completed an 18.9km trip within a randomized between (location: A, B) -within (condition: no display, display message: smiley, display message: "You are speeding!", display message: "Speed control") subject design.

Results show that speed was reduced significantly in the immediate vicinity of these digital displays. However, 500 meters after the devices no significant speed reduction was measured anymore. The message "Speed control" was more effective in reducing speed compared to the other messages. Drivers probably lower their speed when they are confronted with the fact that they might receive a speeding ticket.

Keywords: road safety engineering; digital display; driving simulator

1 INTRODUCTION

Speeding is a major problem in today's society [1–3]. Depending on the road type, 30 to 90 percent of the drivers exceeds the posted speed limit [1]. Several studies have revealed that speeding contributes to 30 percent of all fatal accidents [4–7]. Next to police enforcement [2], [4], [8–10], education [9], [11], [12] and infrastructural redesign [13], [14], digital information displays can be a solution for the speeding problem. Digital information displays have tended to be effective in reducing the number of speed violations and subsequently the number of crashes [14]. One strategy to motivate drivers to comply with the speed limit is to make speeding unattractive.

Especially speed indicator devices are effective in reducing the driving speed [15–18]. There are two central components concerning the effectiveness of these devices, i.e., the conspicuousness of the message and the content of the message. Besides the actual speed, these devices can show several other messages to speeders [19–21]. The length of the messages and the color schemes play an important role in the legibility of the information [22], [23].

Even though flashing messages are discouraged [23], digital displays must be recognizable for drivers. Complicated messages can cause an overload in the mental state of the drivers [24], [25].

Finally, deterrence is a very useful mechanism in achieving a behavioural change [26]. The perceived and actual risk of being detected (punishment) are two crucial elements to obtain this behavioural change [27–29]. This is important because messages on digital displays can inform drivers that the police is controlling their behavior (i.e. detection of undesirable behavior and punishment).

2 THEORETICAL BACKGROUND

Speeding is a problem in most countries with a high level of motorization [2], [3]. The term 'speeding' is used to refer to driving at a speed that is higher than the posted speed limit [30]. Statistics for Belgium indicate that depending on the speed limit of the road, 30 to 90 percent of traffic violates speed limits [1]. In 2010, more than 90 percent of motorists were driving too fast in areas with a speed restricted to 30 km/h (mean speed of 46.3 km/h). There seems to exist a tendency that the percentage of speed violations diminishes when the speed limit increases. This is supported by the fact that in 2010, the percentages of speed violations were 61, 50 and 29 percent on 50-, 70- and 90 km/h-roads respectively [1]. Mean speeds achieved on these roads were 53.6, 71.2 and 83.5 km/h respectively [1].

Different research studies argue that speeding is associated with about 30 percent of all fatal accidents [3–7], [31–34] and consequently is a high-priority traffic safety issue [35]. Speeding extends the distance necessary to come to a stop and increases the travelled distance during the reaction time of the driver (when a dangerous situation occurs) [35]. Kloeden et al. [36], [37] stated that crash rate increases faster with an increase in speed on urban roads compared to rural roads.

Two studies have investigated the relationship between crash rate and speed convictions. Drivers with four or more excessive speed convictions were found to have almost twice the crash rate of other drivers [38]. Another study stated that drivers who are more conspicuous in committing speed violations, will be more often involved in a road accident [39].

A study in the Netherlands has calculated the number of victims related to speeding. The assumption was that 30 percent of all casualties (deaths and hospital admissions) is related to an excessive speed (like mentioned before). It appears that in the Netherlands each year approximately 5 deaths are associated with speeding of 10 km/h above the speed limit in urban areas [7]. This number can even increase to 10 deaths when driver's speed is 15 km/h above the speed limit in urban areas.

Explanations for speeding behavior can be found within three (interactional) domains: driver (personal characteristics), traffic environment and the vehicle [34]. For the driver, the following aspects are known: age, sex, reaction time, alcohol level, ownership of vehicle, experience, education, motivation, attitude, risk perception and risk acceptance [5], [9], [11]. Subjective norms and behavioural norms are very important factors contributing to the intention to speeding. Subjective norms concern an individual's perception of social pressure to perform whether or not a specific behavior [40]. Behavioural norms are even more important because it includes the perceived behavior of other people (e.g. reference groups) [41]. According to De Pelsmacker and Janssens [42] habit formation and the attitude towards speeding are positively correlated to the intention towards speeding. Furthermore, the road image (width, alignment, surroundings, etc.), the weather conditions, the speed limit, the lighting conditions and the traffic density are important issues within the domain of traffic environment [5], [30], [11], [43]. The current generation of vehicles (high maximum speed, high comfort, high power/weight ratio) makes it possible to achieve high speeds [11]. Some drivers even feel more comfortable when they are driving at relatively high speeds, especially when they are rarely (or never) confronted with the negative outcomes of speeding behavior [5], [30].

Because of the relationship between speeding and the number of accidents, reducing vehicle speeds is an important consideration for road safety specialists [18]. According to Departement Mobiliteit en Openbare Werken [10], accidents are caused by human factors (94%), environmental factors (18%) and vehicle factors (5%). Human errors can be: inappropriate behavior (e.g. speeding), insufficient skills/experience, perception errors, etc. The main purpose is to change this behavior and to make inappropriate behavior unattractive [44].

2.1 Speeding countermeasures

Speed management is an integrated approach to achieve a reduction in speeding behavior. Credible speed limits and a clear road categorization are the starting points. It is very important to enforce these speed limits. Moreover, communication (and in a broader sense education) about speed enforcement is an important element for increasing the subjective probability of detection [5], [44].

In order to induce an appropriate speed, a wide variety of enforcement strategies is being applied such as non-automatic speed enforcement [9], [10], [33], fixed/mobile speed cameras [4] and trajectory control [9], [45]. Speed enforcement can lead to a 21 percent reduction in both the number of crashes and the number of severely injured casualties [2], [8], [9], [46]. A disadvantage of automated speed cameras is that drivers sometimes reduce their speed when approaching the camera and increase speed as soon as they have passed by [47].

Adjustments to the road environment (i.e. the engineering part) can also affect speed. According to the Federal Highway Administration [14] these are some engineering countermeasures for reducing the speed: speed hump, speed cushion, raised intersection, lateral shift, center island, roundabout, transverse/longitudinal rumble strips/markings, speed indicator devices, dynamic speed limits, marking the speed limit on the road surface and the creation of a gateway. Under the following conditions, drivers will generally adopt a lower speed: roads with a rough surface, narrow roads, hilly roads, when the boundaries of the lanes are not well defined, visually complex environments, roads with multiple access points, presence of parked vehicles along the roadside [43], roads with a lot of curves, in urban areas, and absence of cycle lanes [34].

Dixon et al. [13] state that well defined transitional speed zones are necessary to encourage drivers to slow down gradually when they transition from a high speed rural road to a lower speed urban road. Roadway features and roadside conditions must help drivers to adjust their driving speed according to the road environment. Traffic calming treatments like gateways, raised intersections, roundabouts, colored pavement, reduction in number of lanes, banners, digital displays, etc. (list is not exhaustive) can reduce the driving speed in rural/urban transition zones.

Since this study focuses on the use of digital displays, the section below will describe in more detail this type of countermeasure.

2.2 Digital displays - Speed Indicator Devices

A speed indicator device (SID) is a radar activated sign that dynamically depicts oncoming vehicle speeds on a large digital display [48]. Studies concluded that these devices have a positive effect in reducing the driving speed and that they are especially effective on speeding drivers [19], [49], [50]. SIDs can be used at problem locations (school zones, dangerous intersections, hazardous curves, etc.) when there is not sufficient police manpower available [19].

Several studies [17], [18], [48], [51] found an overall speed reduction of 2.3 up to 16.1 km/h when a SID was installed. This speed reduction would lead to a reduction in injury collisions (6-9 percent) and fatal collisions (18 percent) at sites where a SID was operational. However, no lasting effect was observed after the SID was removed [18].

SIDs can also be very useful within freeway working zones. When there was no treatment implemented, the speed reduction was only 4 percent. The installation of a SID has led to a further decrease of 6 percent. Police presence was the most effective with a total reduction of 20 percent [15]. Galizio et al. [52] concluded that speed reductions reflect an overreaction effect to the threat of punishment when a marked police vehicle was present. This suggests that driving speed is controlled more by external threat than by the value of safe driving.

In school zones, SIDs also tend to be effective in reducing the driving speed. At SID locations in school zones, the average speed was reduced by about 8.2 km/h [16]. Casey and Lund [53] found that a SID was capable to reduce the proportions of vehicles exceeding the speed limit by at least 16 km/h from 15 percent to 2 percent. But this effect was only achieved during the time the SID was actually deployed. They also suggest that combined police enforcement is a crucial factor (an increased efficacy).

According to Van Houten et al. [54], posted feedback of speeding information is effective because of two reasons. First it introduces a social comparison factor (subjective norm) and second it is possible that the given feedback concerning speeding implies police surveillance.

Messages used on digital displays

When a digital display with the message ‘Your speed is controlled’ is used alongside the road, Van Geirt [20] states that this leads to a reduction in driving speed. On this manner, motorists are informed and being aware that their speed is measured. This message is directly addressed towards them.

A study conducted at work zones in Virginia [19] suggested that the following warning messages had a positive impact on high-speed drivers: “EXCESSIVE SPEED SLOW DOWN”, “HIGH SPEED SLOW DOWN”, “REDUCE SPEED IN WORK ZONE” and “YOU ARE SPEEDING SLOW DOWN”. These messages were only displayed when a driver was speeding and they all generated significant reductions in speed. Aforementioned messages are sometimes preferred to numeric speeds because they tell the driver what action he or she should undertake (it is a strong command). Especially the last message is directly oriented to the speeders [19].

Wrapson et al. [21] performed a study in a 50 km/h zone to measure the effect of a digital display that consecutively depicted one of the following three messages:

- The average speed at the site: motorists may reduce their speed in order to comply with the behavior of the other road users (‘social comparison’)
- A warning that the speed of the drivers was being measured: drivers may reduce their speed in order to avoid possible fines
- A combination of both messages

These three messages had a positive impact (a reduction) on the driving speed. This suggests that both social comparison and possible police enforcement are mechanisms by which driver speed may be reduced [21].

Dudek et al. [22] concluded that there were no significant differences in understanding and average reading time between static and flashing messages on digital displays. Flashing messages may even have adverse effects on the message understanding (especially for unfamiliar drivers) [55].

According to Yang et al. [23] and the Federal Highway Administration [55] variable message sign messages should be static, contain no abbreviations and one-framed. Yang et al. [23] also suggested that amber, green or amber-green combinations are the preferred color schemes with the shortest reading time and highest message comprehension.

2.3 Visual search strategies & mental workload

The relatively low speed limit compliance rates may possibly be explained by a low awareness of drivers towards traffic signs (ranging from 17 to 78 percent) [56]. Therefore it is crucial to adjust the information provision in the environment with the information processing capabilities of the drivers.

Visual search strategies are of high importance in relation with perception of traffic signs [24]. These strategies can be defined as a series of fixations, whereby information is perceived and processed. Especially saccadic eye movements are important to scan the road (actually our eyes jump from one fixation/object to another). Concerning fixation time, the content and the quality of the stimulus are very important [24]. Visual search strategies depend on expectations (experience) of the driver as well as on the path the drivers intend to follow [57]. This means that there must be an optimal match between the visual search strategies of the drivers and the design of the traffic sign.

Mental workload is also a component that influences task performance substantially (e.g. speed limit compliance) [24]. Different tasks demand (limited) resources of an individual and sometimes can interfere with each other. So the mental workload can be seen as the sum of all these task demands (i.e. total demand). When these demands exceed the resources of an individual, task performances of this individual will decrease (individual may lose awareness of the importance of tasks) [25]. Young et al. [58] concluded for example that roadside billboards have a significant influence on the mental workload of drivers. Telephone conversations also increase the mental workload and consequently the driving performance diminishes [59].

Rama et al. [60] hypothesize that a digital speed limit sign (i.e. ditigal display) is more disturbing than a regular speed limit sign. They concluded that drivers were less likely to remember a traffic sign when it was placed near a digital speed limit sign than near a fixed speed limit sign. On the other hand, Hoogendoorn et al. [24] conclude that participants fixated a shorter time on digital displays compared to regular traffic signs.

2.4 Deterrence process

Deterrence is a mechanism used to achieve behavioral change: the behavior of an individual can be modified by making this individual fearful of the consequences when he or she commits something illegal (in this case: a traffic/speeding violation) [26], [61].

Simple deterrence is a concept where people react through fear of possible punishment in the short term. Here, the deterrent effect of a threat is higher when perceived certainty, severity and/or swiftness of punishment increase. In the long term, general deterrence refers to the forming of habits and moral education which are based on the short term threats over time [62]. There exists a belief that the traffic laws are being enforced so that traffic violations will be penalized [63].

The perceived (subjective) and actual (objective) risk of detection are two risk functions within a driver. The subjective risk is the result of the road user's perception of the intensity of enforcement. On the other hand reflects the objective risk the actual level of detection (enforcement) [27–29]. According to Riley [28], an optimal situation is achieved when the subjective risk is equal (or even higher) than the objective risk.

Based on the rational choice theory, Palmer [64] stated that drivers will not commit traffic violations as long as the expected utility of law-abiding actions exceeds the expected disutility of committing an offence.

3 OBJECTIVES

The primary objective of this study is to examine the presence and content of digital information displays on speed at 70 km/h to 50 km/h transition zones, because speeding is a problem within these zones [1], [13]. For this purpose, two real world locations with a high percentage of speeding violations and a comparable cross-sectional profile are selected out of a registered police database. These locations are rebuilt in the driving simulator at the University of Hasselt's Transportation Research Institute (IMOB). At each location, three types of digitally displayed messages and one control section (i.e. no implementation of a digital display) will be implemented.

4 RESEARCH QUESTIONS

The aim of this study is to formulate an answer to the following questions:

a) Does the presence of digital displays (vs. control condition) have an effect on driving behavior?
b) Is there a difference in effectiveness between the messages on the digital displays?
c) How far does the effect of digital displays reach in distance (i.e. distance halo effect)? Concerning the distance halo effect, is there a difference between the messages?

Based on the literature, it is expected that digital information displays and speed indicator devices will reduce speeding. This leads to the following hypothesis: "Digital information displays will reduce the driving speed". Probably the measures "Speed control" (fear) and "You are speeding!" (powerful, confrontational message) will be more effective compared to the smiley condition.

5 METHODOLOGY

5.1 Participants

Eighty volunteers, which all gave informed consent, participated in the study. In total, fourteen participants were excluded. With four a technical problem occurred and ten did not finish the experiment due to simulator sickness. No outliers (with a value more than three times the interquartile distance from the first and third quartiles) were identified. Therefore, 66 participants (41 men), approximately equally divided over four age categories from 20 to 75 years old (mean age 45.2; SD age 17.0) remained in the sample. All participants had at least two years of driving experience.

5.2 Driving simulator

The experiment was conducted on a medium-fidelity driving simulator (STISIM M400; Systems Technology Incorporated). It is a fixed-based (drivers do not get kinesthetic feedback) driving simulator with a force-feedback steering wheel, brake pedal, and accelerator. The simulation includes vehicle dynamics, visual/auditory (e.g. sound of traffic in the environment and of the participant’s car) feedback and a performance measurement system. The visual virtual environment was presented on a large 180° field of view seamless curved screen, with rear view and side-view mirror images. Three projectors offer a resolution of 1024 × 768 pixels and a 60 Hz frame rate. Finally, data were collected at frame rate.

A technical restriction of the driving simulator is that the actual driving speed cannot be depicted on a digital display alongside of the road. Consequently, it is not possible to implement a so called speed indicator device into the driving simulator environment. But the driving simulator is capable of showing speed-depending images. A laughing smiley is for instance displayed when the driving speed is below the speed limit and a sad smiley is displayed when the participant is speeding.

5.3 Scenario

Road segment selection and description

The objective was to select two similar (i.e. with a comparable cross-sectional profile and road environment) roads with (similar) percentages of speeding violations. This search for candidate locations was based on a registered police database. To search for similar roads, the following variables were used: percentage of speed violations (i.e. the number of speed violations divided by the number of controlled vehicles), speed limit, number of lanes, presence of a central barrier, presence of a cycling lane, presence of a footpath, presence of zebra crossings, presence of parking spaces alongside of the road, presence of houses or other buildings, length of the road section (according to street name and separated for each speed limit), number of curves, number of intersections, and the type of priority. The speed violations and speed limit data were extracted from the police database and all the environmental variables were investigated through satellite images from Google Earth. The roads were first classified by their percentage of speed violations, because roads with a high percentage are more problematic than roads with a low speeding percentage. To make a final decision, the most interesting (and comparable) locations were visited.

The two selected roads have a speed limit of 50 km/h with 2x1 lanes and an adjacent cycling path. At each location, three types of digitally displayed messages will be implemented in the driving simulator. More detailed information about the selected locations and these measures can be found below and under FIGURE 1.

Road segment development

To rebuild the selected locations in the driving simulator environment, a procedure called geo-specific database modeling [65] was followed. This procedure consists of replicating a real-world driving environment in a simulated environment. Consequently, participants are offered a real driving scenario instead of a fictive one. In order to reproduce the existing situations as realistic and detailed as possible, we made use of photographs, videos, detailed field measurements, AutoCAD simulations, and Google Street View. The purpose of the geo-specific database modeling technique is to increase reliability and validation of the experiment and the results.

Scenario design

FIGURE 1f includes an overview of the scenario of the two selected locations with the corresponding speed limits. Each location has a length of 3,100m where the digital display is set at the relative distance of 0m. In these test segments only oncoming traffic will be simulated to prevent any interaction between the participant and other traffic.

Location A first has a 1,280m long rural section with a maximum speed limit of 90 km/h and no houses alongside of the road. Then the participant drives through a 700m long road section with after 170m a traffic light that is turned on green. The first part can be considered as rural, while the environment after the traffic light is more a transition area between rural and urban. Subsequently, the urban area (50 km/h) begins and the digital display is installed 170m further along the urban area. A roundabout is situated 450m after the digital sign and the urban area ends 500m after the roundabout. An impression of location A in the real world and the replica in the driving simulator is given in FIGURE 1a.

Location B doesn't have a 90 km/h section, but begins with a 1700m long rural section where the speed limit is 70 km/h. Subsequently, participants enter an urban area where the digital display is installed after 575m. A roundabout is situated 325m afther the digital display and again the built-up area ends 500m after this roundabout. An impression of location B in the real world and the replica in the driving simulator is given in FIGURE 1b.

The sample is devided into two groups: one group will drive in location A and the other group will pass location B. All participants are exposed to the four conditions: control condition (without digital display), smiley, "You are speeding!" and "Speed control". Some filler pieces, with a length of about two kilometers, are implemented between the randomly assigned test segments. They introduce some variation into the simulator tour to prevent that habituation occurs, but they do not influence driving behavior on the analysis segments. All in all, participants will complete a trip of 18.9km in a simulated environment with clear and dry weather conditions.

The four possible conditions that are used in the driving simulator experiment are the following:

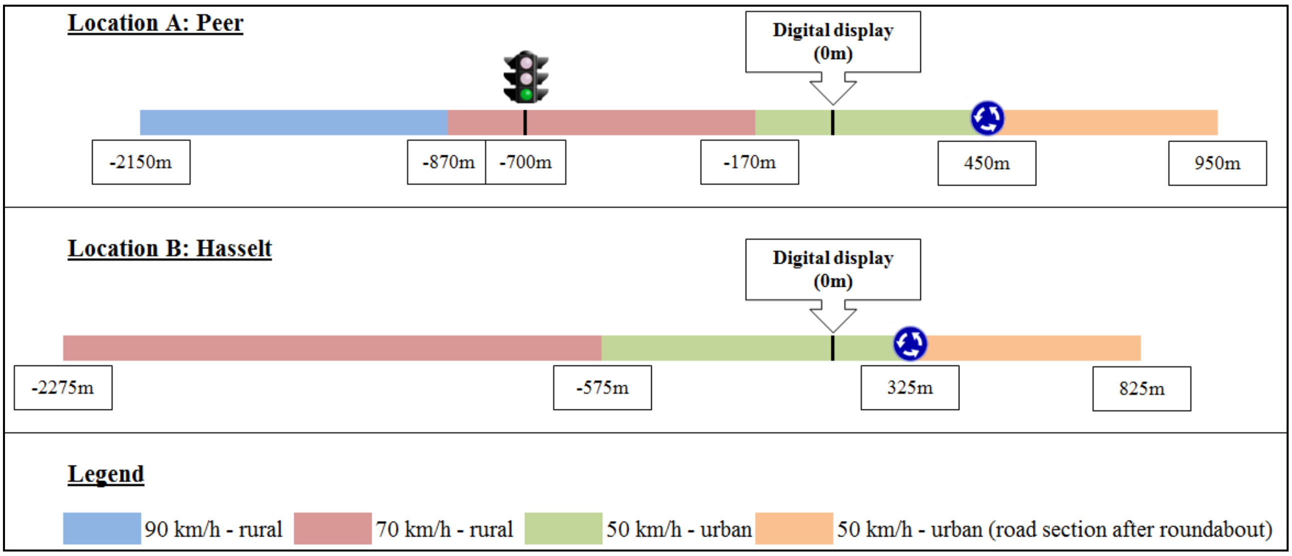
- Control condition: no digital display was implemented

- Measure 1: a digital display with a laughing smiley when the driver's speed is below the speed limit (50 km/h); otherwise a sad smiley (see FIGURE 1d)
- Measure 2: a digital display with the text "You are speeding!" when the driver is exceeding the speed limit; otherwise "Thank you" (see FIGURE 1e)
- Measure 3: a digital display with a warning sign that the driver's speed is being controlled by the police: "Speed control". This message is always displayed, thus independent of the current driver's speed (see FIGURE 1c).

(a)

(b)

(c) (d) (e)



(f)

FIGURE 1 (a) Real world vs. simulator images at location A; (b) Real world vs. simulator images at location B; (c) Digital display speed control; (d) Digital display smiley; (e) Digital display "You are speeding!"; (f) Scenario overview.

Procedure and design

Participants were asked for their voluntary cooperation and fill out a form with some personal data (e.g. date of birth, driving experience, gender). After a general introduction, the simulator session began with two practice trips of respectively three and seven kilometers. Drivers acquainted themselves with the driving simulator by handling various traffic situations (e.g. highway, roundabout, built-up area, curve, traffic lights) during the practice sessions. Then they completed the experimental trip of 18.9km at one of the two locations. This leads to a randomized between (location: A, B) -within (condition: no display, display message: smiley, display message: "You are speeding!", display message: "Speed control") subject design. Subjects were asked to drive as they normally would do with their own car and apply the traffic laws as they would do (or would not do) in reality. After the experimental session, participants were asked to fill out a questionnaire. In this postal survey participants were asked to give scores from 1-10 to twenty different messages that were projected on a screen. The exact question posed to the participants was: *"To what extent do you think that speeders will adapt their behavior when following messages are displayed in real life on a digital panel?"*. Subjects could mark points on a scale from 1 (not at all) to 10 (completely) with an interval of 0.25.

5.4 Data collection and analysis

Dependent measures

Many driving performance measures for longitudinal and lateral control were recorded by the driving simulator. For this study, measures for longitudinal control are of interest: mean speed [km/h], standard deviation (SD) of speed [km/h], mean longitudinal acceleration/deceleration (acc/dec) [m/s^2], and SD of longitudinal acc/dec [m/s^2].

Mean speed is selected because it is used as an indicator for safe driving [9]. Mean acc/dec is interesting because fluctuations in acc/dec indicate (large) changes in speed.

Sometimes it is difficult for other drivers to anticipate safely to these fluctuations [66]. The SD of speed and SD of acc/dec can reveal if there exist (large) differences in these measures on a specific road section. A large SD indicates large differences in speed or acc/dec on that road section.

Data analysis

Data analysis for the aforementioned measures (mean speed, SD speed, mean acc/dec, and SD acc/dec) is based on a number of measurement zones along the driving scenario. First, one random zone of 500m was analyzed (starting 1750m before the digital display). This analysis was carried out to see whether significant differences exist between the four conditions. Under normal circumstances, no significant differences may exist because the measures don't have an influence at this distance. A randomized between (location: A, B) - within (condition: no display, display message: smiley, display message: "You are speeding!", display message: "Speed control") subject multivariate analyses of variance (MANOVA) was conducted on the four speed parameters.

Since this study focuses on driving behavior (cf. research questions a and b) nearby digital displays, six zones before and six zones after the displays were analyzed. Each zone has a length of 25m, resulting in analysis sections of 300m (from -150m until 150m on FIGURE 1f). Therefore, two times (before and after) a 2 (location: A, B) x 4 (condition: no display, display message: smiley, display message: "You are speeding!", display message: "Speed control") x 6 (zones of 25m) between-within subject MANOVA with additional ANOVA's were conducted on the four speed parameters.

To examine how far the effect of digital displays reach in distance (cf. research question c), another analysis was conducted. After the roundabout (see FIGURE 1f; 450m after digital display at location A; 325m after digital display at location B), six zones of 50m were analyzed. Therefore, a 2 (location: A, B) x 4 (condition: no display, display message: smiley, display message: "You are speeding!", display message: "Speed control") x 6 (zones of 50m) between-within subject MANOVA with additional ANOVA's were conducted on the four speed parameters.

Finally, a MANOVA was conducted to examine if the results of the postal survey were significantly different.

For all analyses, p-value was set at 0.05 for the reported MANOVA's F- and probability values (Wilks' Lambda). For the reported ANOVA's, corrected F- and probability values (Greenhouse-Geisser) are described. Outliers were considered when the value exceeds three times the interquartile distance from the first and third quartiles, but this was never the case.

6 RESULTS

6.1 Control zone

The purpose of the control zone is to see whether significant differences exist between the conditions on a road section where the digital displays have no influence (i.e. 1750 before the displays). The MANOVA revealed that only Location is a significant factor ($F_{(4, 61)} = 17.6$, $p < .0005$).

Univariate analysis showed that three out of four dependent measures were significant for Location: mean speed ($F_{(1, 64)} = 32.0$, $p < .0005$); SD speed ($F_{(1, 64)} = 6.0$, $p = .017$); and SD acc/dec ($F_{(1, 64)} = 11.2$, $p = 0.001$). The mean speed at location A (M = 81.191, SD = 1.238) was 9.749 km/h higher than at location B (M = 71.442, SD = 1.199). Furthermore, the SD of speed and acc/dec were respectively 0.684 km/h (location A: M = 2.657, SD = 0.202; location B: M = 1.973, SD = 0.194) and 0.081 m/s² (location A: M = 0.228, SD = 0.017; location B: M = 0.147, SD = 0.017) higher for location A.

Within this control zone, no significant differences exist between the conditions (as was expected).

6.2 Immediate vicinity of digital displays

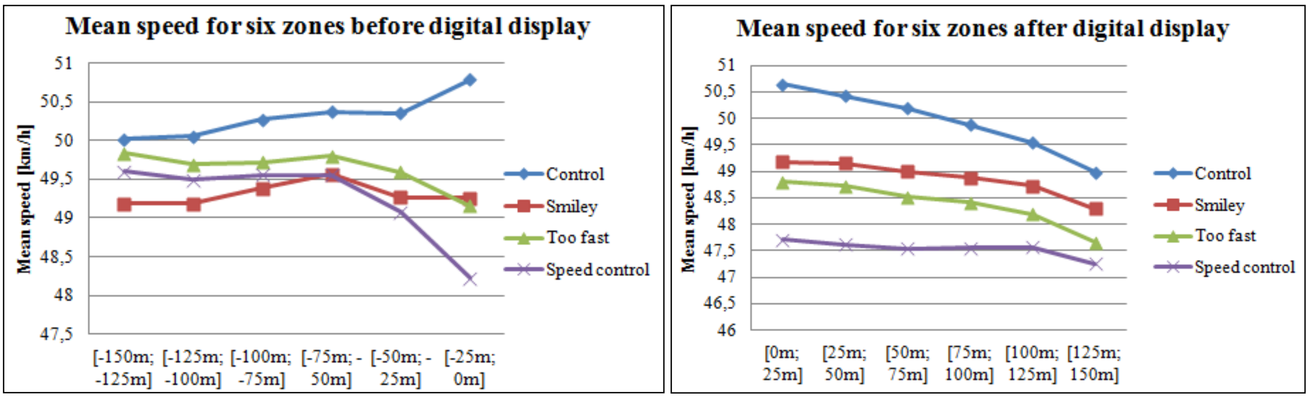
TABLE 1 presents the multivariate and univariate statistics for the dependent measures for six zones of 25m before and six zones of 25m after the digital displays (cf. research questions a and b). For the six zones before the digital displays, the MANOVA revealed that the factors Condition, Zone, Zone x Location, and Condition x Zone are significant at a 5% level. Because the interaction term Condition x Zone is significant, the main effects of Condition and Zone will not be discussed separately. The significant interaction term Zone x Location indicates that the differences between the zones are significantly different for both locations. Because this is beyond the scope of this research and not related to the research questions, the interaction term Zone x Location will not be discussed further in detail. The factor Condition doesn't have a significant effect on this interaction term because the interaction term Condition x Zone x Location is not significant.

Univariate statistics revealed that Condition x Zone is only significant for mean speed (and thus not for the other dependent measures). FIGURE 2a clearly shows that the highest mean speed (i.e. of both locations together) is measured in the control condition. In zones five and six, mean speed decrease for all other conditions and the most for the police control message. When this interaction term is analyzed for each condition, only a significant effect ($F_{(2, 103)} = 5.5$, $p = 0.009$) for the factor Zone is found for the speed control condition. For this condition, a significant speed reduction ($p < .0005$) exists between zones five (M = 49.072, SD = 0.500) and six (M = 48.222, SD = 0.500).

When separate tests are conducted for Condition x Zone for each zone, no significant differences in mean speed between the conditions are found between -150m and -50m (i.e. zones one, two, three, and four). For zones five ($F_{(3, 166)} = 3.3$, $p = 0.030$) and six ($F_{(3, 190)} = 8.3$, $p < .0005$) a significant effect is found for the factor Condition. For zone five (-50m to -25m), only a significant difference ($p = 0.025$) is found between the control (M = 50.357, SD = 0.497) and smiley (M = 49.270, SD = 0.475) condition. Within zone six (-25m to 0m), significant differences are found between the control (M = 50.785, SD = 0.482) condition and all other conditions. The largest significant difference appears with the speed control condition ($p < .0005$; M = 48.222, SD = 0.500), followed by the too fast condition ($p = 0.016$; M = 49.162, SD = 0.500), and finally the smiley condition ($p = 0.017$; M = 49.255, SD = 0.479). Between the three digital displays no significant effects were revealed (although the speed control condition has the lowest mean speed).

Concerning the six zones of 25m after the digital displays, the MANOVA revealed only significant effects of Condition and Zone. Univariate statistics found that the factor Zone is significant for all dependent measures and factor Condition only for mean speed. More detailed analysis indicated that the mean speed between the control (M = 49.950, SD = 0.500) and too fast (p = 0.005; M = 48.420, SD = 0.385) condition, and between the control and speed control (p < .0005; M = 47.560, SD = 0.356) condition differs significantly. Obviously, the lowest mean speed was obtained with the speed control condition (cf. FIGURE 2b). When factor Zone is analyzed in more detail, significant differences were revealed between zones five (M = 48.532, SD = 0.349) and six (M = 48.085, SD = 0.392) for mean speed (p < .0005). Between zones one (M = 0.259, SD = 0.018) and two (M = 0.220, SD = 0.018) significant differences were found for SD of speed (p = 0.017). For mean acc/dec (p = 0.031) significant differences were measured between zones four (M = -0.012, SD = 0.012) and five (M = -0.048, SD = 0.013). Finally, between zones four (M = 0.031, SD = 0.004) and five (M = 0.050, SD = 0.006), significant differences (p = 0.013) were also measured for SD of acc/dec.

For the zones in the immediate vicinity of the digital displays, a significant effect between the control condition vs. the too fast and speed control conditions was found from about 50m before the digital display. The speed control condition was found to be the most effective in reducing speed.



(a) (b)

FIGURE 2 (a) Mean speed for zones before digital display; (b) Mean speed for zones after digital display.

TABLE 1 Multivariate and Univatiate Statistics for Dependent Measures: Mean Speed, Standard Deviation (SD) of Speed, Mean Acceleration/Deceleration (acc/dec), and SD of Acceleration/Deceleration

	6 zones before		**6 zones after**	
Variable	*F (dfs)*	*p*	*F (dfs)*	*p*
MANOVA				
Location	0.8 (4, 61)	0.511	2.2 (4, 61)	*0.081*
Condition	5.7 (12, 53)	**< .0005**	6.3 (12, 53)	**< .0005**
Condition x Location	1.6 (12, 53)	0.125	1.6 (12, 53)	0.134
Zone	9.7 (20, 45)	**< .0005**	3.0 (20, 45)	**0.001**
Zone x Location	2.0 (20, 45)	**0.025**	1.3 (20, 45)	0.258
Condition x Zone	7.2 (60, 5)	**0.017**	1.7 (60, 5)	0.281
Condition x Zone x Location	0.4 (60, 5)	0.937	1.3 (60, 5)	0.418
Univariate statistics				
Mean speed				
Condition	3.2 (3, 173)	**0.028**	10.7 (3, 187)	**< .0005**
Zone	1.5 (2, 105)	0.234	9.4 (1, 88)	**0.001**
Zone x Location	1.0 (2, 105)	0.352		
Condition x Zone	3.8 (4, 280)	**0.004**		
SD speed				
Condition	0.7 (3, 190)	0.567	1.1 (3, 183)	0.347
Zone	56.0 (3, 186)	**< .0005**	2.8 (3, 165)	**0.048**
Zone x Location	1.9 (3, 186)	0.136		
Condition x Zone	1.2 (7, 463)	0.287		
Mean acc/dec				
Condition	6.1 (3, 179)	**0.001**	2.3 (3, 182)	*0.082*
Zone	10.3 (3, 185)	**< .0005**	4.0 (3, 167)	**0.012**
Zone x Location	4.4 (3, 185)	**0.006**		
Condition x Zone	1.0 (8, 518)	0.406		
SD acc/dec				
Condition	3.8 (3, 183)	**0.013**	0.7 (3, 175)	0.541
Zone	10.1 (3, 169)	**< .0005**	7.0 (3, 192)	**< .0005**
Zone x Location	1.4 (3, 169)	0.256		
Condition x Zone	1.6 (7, 417)	0.126		

p ≤ 0.05; *p ≤ 0.1*

6.3 Distance halo effect

For effect duration in distance (cf. research question c), six consecutive zones of 50m after the roundabout were considered (speed limit is equal to 50 km/h). The MANOVA revealed that only factor Zone is significant ($F_{(20, 45)}$ = 322.3, p < .0005). This means that the values differ signicantly between the six zones.

For this factor, univariate analysis indicates that all dependent measures are highly significant: mean speed ($F_{(3, 161)}$ = 1556.5, p < .0005); SD speed ($F_{(2, 101)}$ = 205.3, p < .0005); mean acc/dec ($F_{(4, 236)}$ = 162.7, p < .0005); and SD acc/dec ($F_{(2, 132)}$ = 127.1, p < .0005).

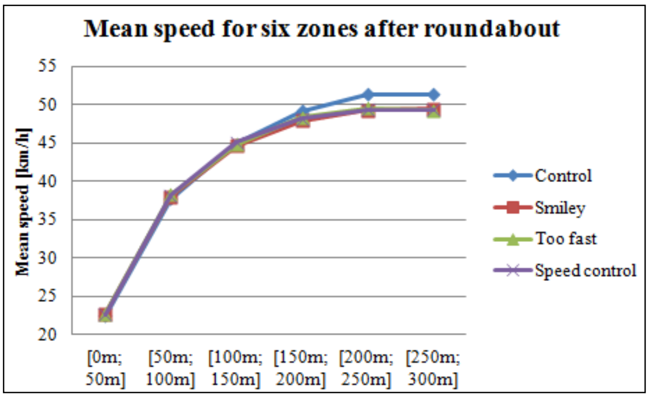
The mean speeds (km/h) in zones one until six are respectively 22.637 (SD = 0.493), 38.070 (SD = 0.522), 44.867 (SD = 0.526), 48.434 (SD = 0.468), 49.856 (SD = 0.443), and 49.867 (SD = 0.454). FIGURE 3a clearly shows that participants accelerate after the roundabout up to 50 km/h and that no (significant) differences can be found between the conditions. From zone five (i.e. 100m-125m after the roundabout) mean speed seems to be constant around 50 km/h. FIGURE 3a might indicate that after 300m a (significant) difference arises between the control condition and the other conditions. However, when a segment from 200m to 450m (i.e. zones five until nine) after the roundabout is analyzed, MANOVA revealed no significant differences ($F_{(12,\ 53)} = 1.1$, $p = 0.361$) between the conditions.

For the SD of speed, mean values (km/h) for zones one until six are 4.406 (SD = 0.209), 2.992 (SD = 0.104), 1.570 (SD = 0.065), 0.911 (SD = 0.054), 0.659 (SD = 0.043), and 0.515 (SD = 0.050). FIGURE 3b indicates a high SD of speed in zones one until three. This means that there is a large difference between speeds within each zone. These differences (and so the SD) decrease in the zones four until six, which means that speeds within these zones are approximately equal.

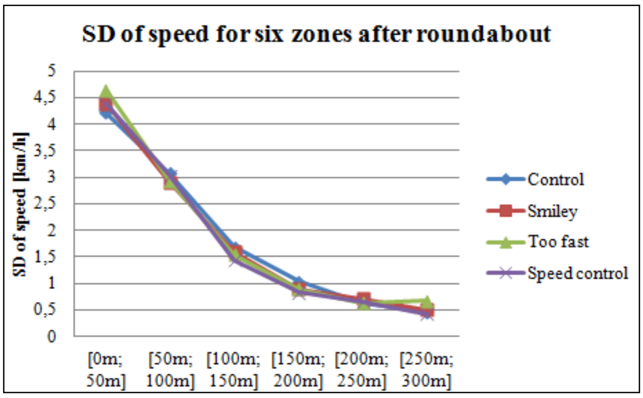
Zones one until six have the following mean values (m/s²) for mean acc/dec: 0.371 (SD = 0.019), 0.591 (SD = 0.022), 0.329 (SD = 0.017), 0.175 (SD = 0.016), 0.055 (SD = 0.014), and -0.014 (SD = 0.010). FIGURE 3c shows this tendency that subjects accelerate after leaving the roundabout (with a peak in zone two) and that acceleration decreases to approximately zero at zone six. This means that participants maintain a rather constant speed.

Finally, FIGURE 3d depicts the gradually decrease in SD of acc/dec from zone one to six. This indicates that the difference in acc/dec within zone one is much larger than within zone six. Mean values (m/s²) for SD of acc/dec from zones one until six are: 0.650 (SD = 0.037), 0.323 (SD = 0.018), 0.233 (SD = 0.015), 0.146 (SD = 0.012), 0.104 (SD = 0.009), and 0.081 (SD = 0.008).

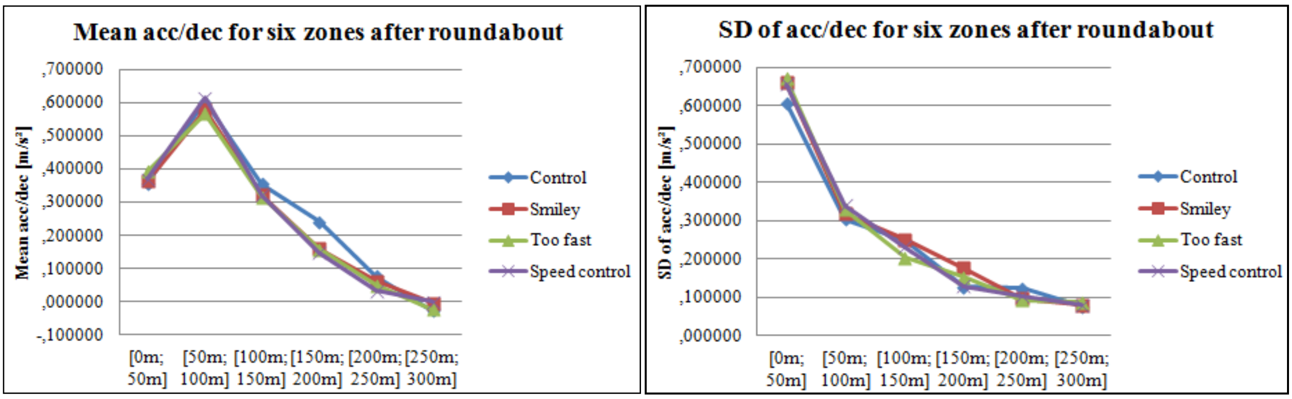
Concerning the distance halo effect, no significant differences were revealed between the conditions after the roundabouts (at 450m and 325m respectively).



(a)



(b)



(c) (d)

FIGURE 3 Distance halo effect of all conditions for (a) mean speed; (b) SD of speed; (c) mean acc/dec; (d) SD of acc/dec.

6.4 Postal survey

The MANOVA revealed that the scores for the different messages were significant ($F_{(9, 56)}$ = 15.3, p < .0005). FIGURE 4 shows the three messages with the highest scores. A message of speed control in combination with a sign (cf. FIGURE 4a) tend to be the most effective (M = 8.017, SD = 0.163). This message was significantly different from all other messages (p ≤ 0.01), except from the messages in FIGURE 4b (p = 0.071) and FIGURE 4c (p = 0.159). FIGURE 4b shows a text message where drivers are warned for a speed control (M = 7.785, SD = 0.170) and FIGURE 4c includes a message which communicates that a fine for speeding amounts at least 50 euros (M = 7.710, SD = 0.222).

These results support the results obtained from the experimental session. Likewise in this postal survey, the message indicating a speed control was the most effective in the experimental session in the driving simulator.

(a) (b) (c)

FIGURE 4 Digital display TOP-3 of postal survey (a) digital display with highest mean score "Speed control + sign"; (b) digital display with second highest mean score "Speed control"; (c) digital display with third highest score "Fine at least 50 euros".

7 DISCUSSION

In this study, two real-world road sections with a high percentage of speeding offences were selected and replicated in the driving simulator. Both locations had a very comparable cross-section profile with a transition from a rural to an urban environment. At every location four conditions (control, smiley, too fast, speed control) were implemented.

First, a control zone (1750m before the digital display and with a length of 500m) was analyzed. No significant difference was found between the four conditions. This may be considered as a logical result because on that road section the digital display can not have an effect on the driving behavior. However, the factor Location was significant which implies that the speed on both locations was significantly different from each other. This also is logical because at location A the speed limit was 90 km/h and at location B 70 km/h. This difference in speed limit is not relevant, because the main purpose of this analysis was to analyze if a difference in speed existed between the four conditions.

7.1 Six zones before digital display

Analysis of the six zones (each with a length of 25m) before the digital display revealed that the smiley leads to a significant speed reduction of 0.298 km/h between zones four (i.e. -75m;-50m) and five (i.e. -50m;-25m). A significant speed reduction (0.850 km/h) was also found for the speed control condition between zones five and six (i.e. -25m;0m). This implies that the speed control condition had a larger speed reduction, but that the speed reduction with the smiley condition occurred 25m earlier. A possible explanation for the latter can be that the different messages were legible from different distances. No significant speed reduction existed for the too fast condition.

Within zone six (i.e. 0-25m before the digital display) significant differences in mean speed are found for all conditions compared to the control condition (50.785 km/h): smiley (-1.530 km/h), too fast (-1.623 km/h), and speed control (-2.563 km/h). At this distance, all conditions were clearly readable and it can be concluded that the speed control condition caused the largest speed reduction. This is supported by the fact that participants rated the speed control condition as highest in the postal survey. No significant differences were revealed for the other dependent measures or between the three experimental conditions (i.e. digital messages).

7.2 Six zones after digital display

For the six zones (each with a length of 25m) after the digital display, factors Condition and Zone were significant. The factor Condition indicated that the mean speed for the control condition (49.950 km/h) significantly differed from the conditions too fast (-1.530 km/h) and speed control (-2.390 km/h). This means that the reduction in mean speed (within these 150m) was the largest for the speed control condition, followed by the too fast condition. This is again supported by the fact that participants rated the speed control condition as highest in the postal survey. For the factor Condition no other dependent measures tended to significant.

The speed reductions above (ranging from 1.5 to 2.4 km/h) are generally lower that the speed reductions obtained in other (field) experiments where a SID was implemented. Other studies found a reduction of 8.2 km/h [16], 6% (i.e. 3 km/h when the average speed is equal to 50 km/h) [15], 5.3 km/h [17], and 2.24 km/h [18] after a SID was installed. Studies about other traffic calming measures (e.g. transverse rumble strips) found an average speed reduction of 3.2 km/h [48] and 5.9 km/h [67].

The fact that the speed control condition is the most effective in reducing speed can be explained because Galizio et al. [52] state that driving speed is controlled more by external threat (of receiving a fine) than by the value of safe driving. Furthermore, Van Houten et al. [54] concluded that posted feedback of speeding information is effective because drivers think that this feedback implies police surveillance. But Casey and Lund [53] state that combined police enforcement is a crucial factor to increase efficacy. This means that drivers won't reduce their speed if they know that their speed is not controlled by the police (although a speed control message is communicated via a digital display). It can be argued that the speed control condition is linked to the three E's: Enforcement (i.e. speed control), Engineering (i.e. digital display) and Education (i.e. sensitization).

Considering the factor Zone, significant differences were found for mean speed between 100m-125m and 125m-150m (-0.447 km/h). This indicates that subjects didn't adjust their driving speed abruptly just after the digital display (because the zones right after the digital display don't differ significantly). Participants maybe lowered their speed in zone six (125-150m after the digital display) because the roundabout was yet visible at this distance. Furthermore, a significant effect was measured for SD of speed between zones one and two (-0.039 km/h). This means that speed differences were larger just after the digital panel (i.e. zone one) than in zone two. For the mean acc/dec also a significant effect was found between zones four (-0.012 m/s²) and five (-0.048 m/s²). The minus sign indicates that participants decelerated in both zones, but that the deceleration was larger in zone five. An explanation for this phenomenon can't be found at first sight. Finally, a significant differce (+0.019 m/s²) was found for the SD of acc/dec between zones four and five. This means that acc/dec differences were larger in zone five than in zone four. This finding is in line with the finding for the mean acc/dec, where zone five had a larger deceleration than zone four.

7.3 Distance halo effect

To see how long the speed reducing effect of the digital displays was maintained in distance (cf. research question c), six zones of each 50m were analyzed after the roundabout (i.e. 450m after digital display at location A and 325m at location B). The MANOVA revealed that no significant differences are found between the four conditions at this road section. Therefore, the conclusion is that the speed reduction effect of the messages is minimized after the roundabouts (i.e. after 450m-750m and 325m-625m respectively).

On the other hand, this analysis revealed that factor Zone was significant for this road section. This can be easily explained by the fact that participants accelerated after leaving the roundabout. All dependent measures were highly significant and they increased/decreased gradually between zones one and six: mean speed (22.637 vs. 49.867 km/h), SD of speed (4.406 vs. 0.515), mean acc/dec (0.371 vs. -0.014), and SD of acc/dec (0.650 vs. 0.081). These figures indicate that participants accelerated to almost 50 km/h and then maintain a rather constant speed. The decreasing values of the SD of speed and acc/dec mean that differences were much larger in zone one (accelerating zone) compared to zone six (zone with rather constant speeds).

The local effect of the digital displays is supported by a study of Walter and Broughton [18]. They found in their field experiment that the speed reducing effect of SID was limited to a stretch of road about 400m after the SID. Another conclusion was that no lasting effect was observed after the SID was removed [18], [53]. Furthermore, Ariën et al.

[68] also concluded that traffic calming measures (in this case: gate constructions) only reduced the speed locally.

8 LIMITATIONS AND FUTURE RESEARCH

Some can argue that driving simulator experiments are not realistic, because subjects are driving in a virtual environment. However, Hoogendoorn et al. [24] have shown that digital displays can be used in a driving simulator experiment. Furthermore, Bella [69] and Godley et al. [70] concluded that speed parameters can be validated as dependent measures for research using a driving simulator.

Comparing the results of this study with the results of a field experiment (at both locations) can also increase the reliability of the findings in this paper. At this moment, data is being collected at the field but these are not yet available.

Future research about the topic of digital panels can be done concerning the effect duration in time. This study reveals that digital panels reduce the driving speed, but maybe this effect will disappear over time (when drivers are used to these displays). Another study can be conducted about the place where digital displays are implemented. Maybe different effects are found on other road types or roads with other speed limits. Further research can be done about workload and visual search strategies concerning digital displays. Drivers sometimes might not see the digital display or might not have sufficient mental resources to process the displayed message. Furthermore, the legibility of digital displays in the driving simulator also can be an interesting topic for future research. As mentioned before in the discussion, messages on digital displays can be legible from different distances. Finally, the duration of the effect in distance may be examined in more detail. In this study, no effect on driving behavior was measured anymore after the roundabout. We don't know whether the distance that one has passed after the digital display or the passing of a roundabout (decelerating/accelerating) had an influence. A combination of both even might be possible.

9 CONCLUSION

Considering the results for mean speed, digital displays can be considered as a successful speed reducing measure.

Before the digital display already a speed reduction was observed compared to the control condition (i.e. no implementation of a digital display; mean speed is 50.785 km/h): smiley (-1.530 km/h), too fast (-1.623 km/h), and speed control (-2.563 km/h).

Right after the digital display also a speed reduction was found compared to the control condition (49.950 km/h): too fast (-1.530 km/h) and speed control (-2.390 km/h).

It can be concluded that the speed control condition was the most effective in reducing the driving speed, followed by respectively the too fast and smiley condition. This finding was also supported by the results of the postal survey.

However, results have shown that this speed reducing effect was not retained in distance. Already 325-450m (i.e. after the roundabout) after the devices, no significant differences were found anymore between the experimental conditions.

Considering all aspects, a policy recommendation is that digital displays with the message “Speed control” can be implemented at sites with a speeding problem. However, for maintaining the speed reducing effect and the credibility of these displays, real speed controls (i.e. police surveillance) should be performed at these locations.

10 ACKNOWLEDGEMENTS

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APPENDICES

Appendix A

The figure below shows two groups with comparable roads within each group. These roads are all visited by the research team and the Albertkanaalstraat in Hasselt and the Deusterstraat in Peer were the two locations with the most matching cross-section profiles.

ID	Straatnaam	Aantal boven limiet (op basis van Excel-bestand)	Aantal gecontroleerde voertuigen	Overtredingspercentage	Gemeente	Maximum-snelheid
Groep 1						
1	Albertkanaalstraat	169	750	22,53%	Hasselt	50
10	Kleine Hemmenweg	37	119	31,09%	Zonhoven	50
21	Deusterstraat	222	1181	18,80%	Peer	50
31	Firmin Jacobslaan	19	132	14,39%	Halen	50
Groep 2						
9	Kiewitstraat	901	4315	20,88%	Hasselt	50
19	Berkenlaan	156	682	22,87%	Leopoldsburg	50
34	Sint-Jorislaan	112	944	11,86%	Herk-de-Stad	50
39	Groenstraat	60	303	19,80%	Lummen	50
40	Vandermarckestraat	32	293	10,92%	Lummen	50

* Opmerking: Vermits in de eerste politiezone uitsluitend wegen voorkomen met een maximumsnelheid van 50 km/u, worden in de andere politiezones ook enkel wegen met deze maximumsnelheid geselecteerd

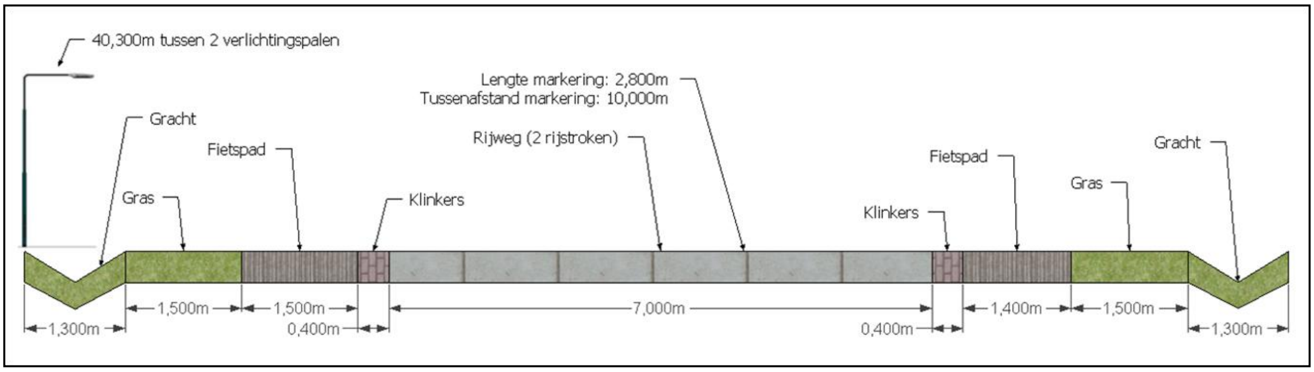
** Opmerking: Bij een verdere filtering wordt in de 2e groep een goede match bekomen. In groep 1 zijn er verschillen omtrent de aanwezigheid van fietspad / voetpad. Bij groep 1 is de voorrangsregeling 'Hoofdweg' en bij groep 2 'Voorrang van rechts'.

- (red) Politiezone HAZODI
- (blue) Politiezone Kempenland
- (brown) Politiezone West-Limburg

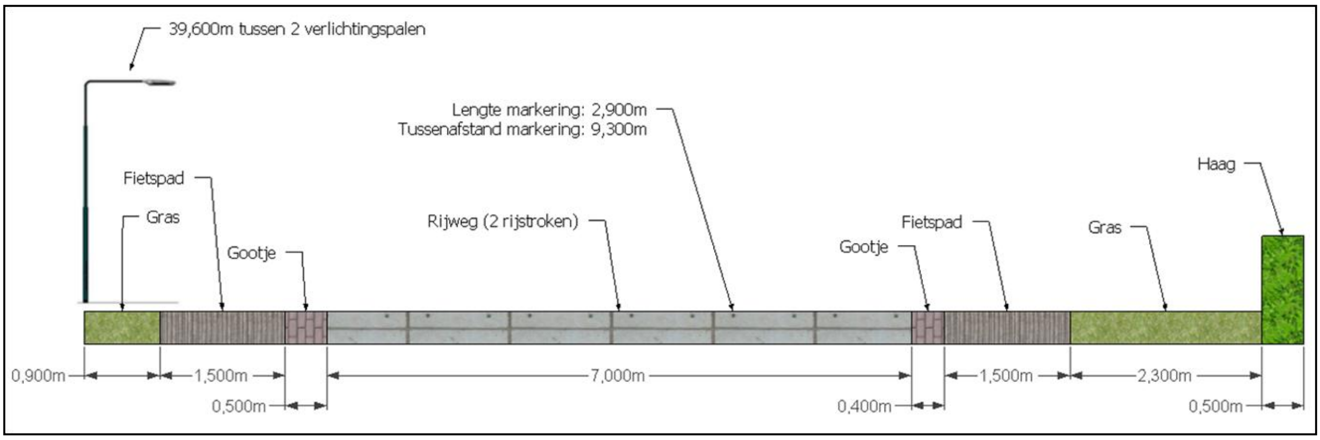
Appendix B

The figures below present the cross-section profile and some corresponding photographs of the Deusterstraat in Peer (with respectively a speed limit of 90, 70, and 50 km/h).

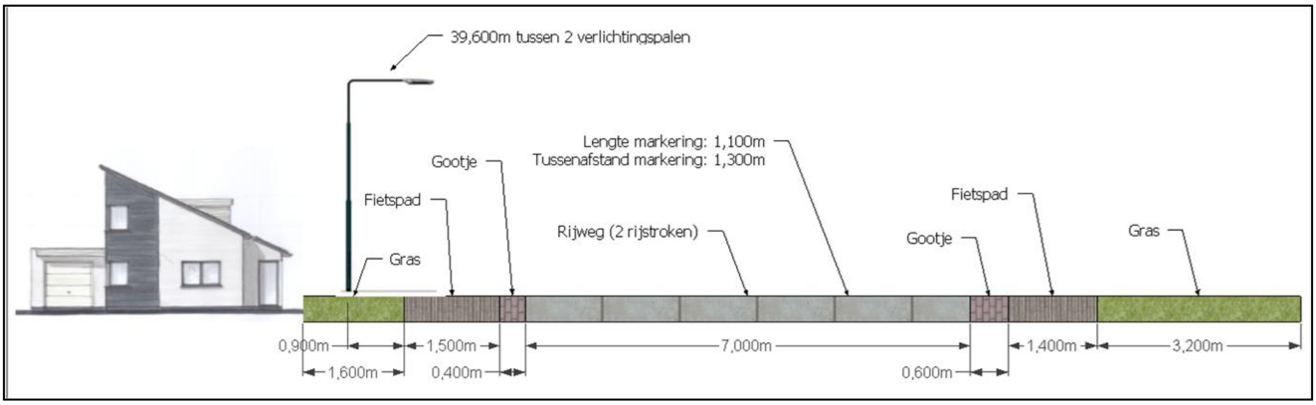
90 km/h



70 km/h



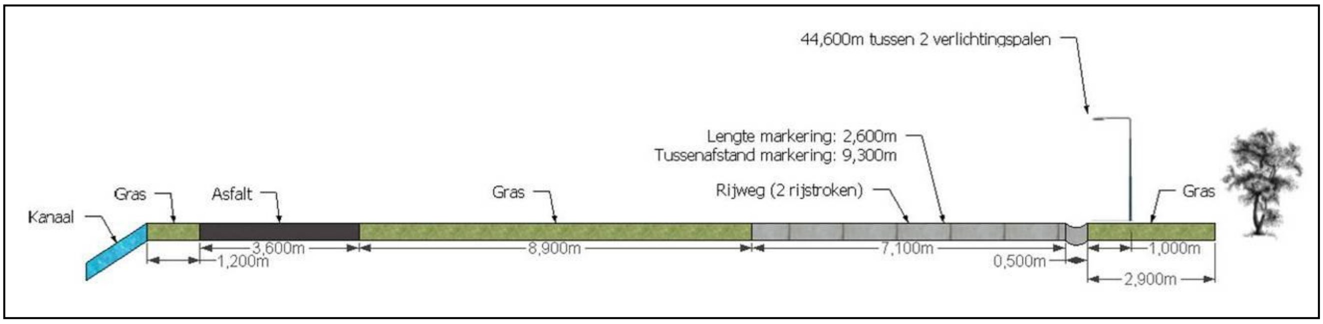
50 km/h (built-up area)



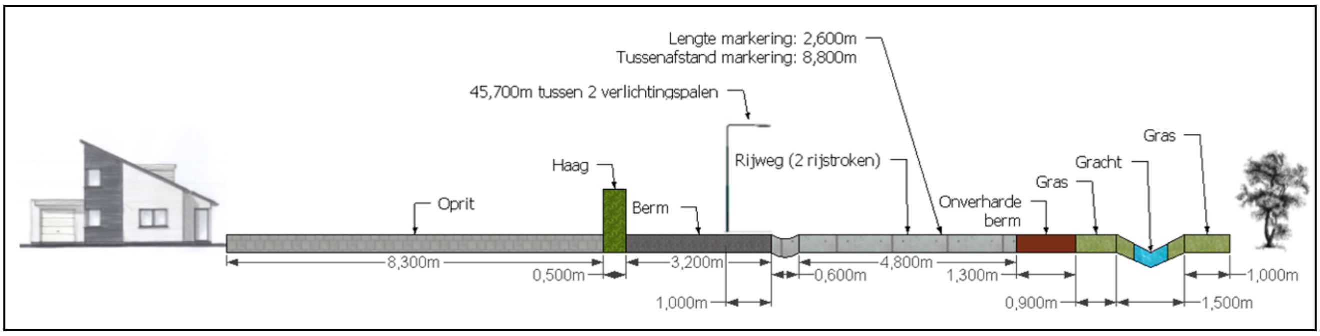
Appendix C

The figures below present the cross-section profile and some corresponding photographs of the Albertkanaalstraat in Hasselt (with respectively a speed limit of 70 and 50 km/h).

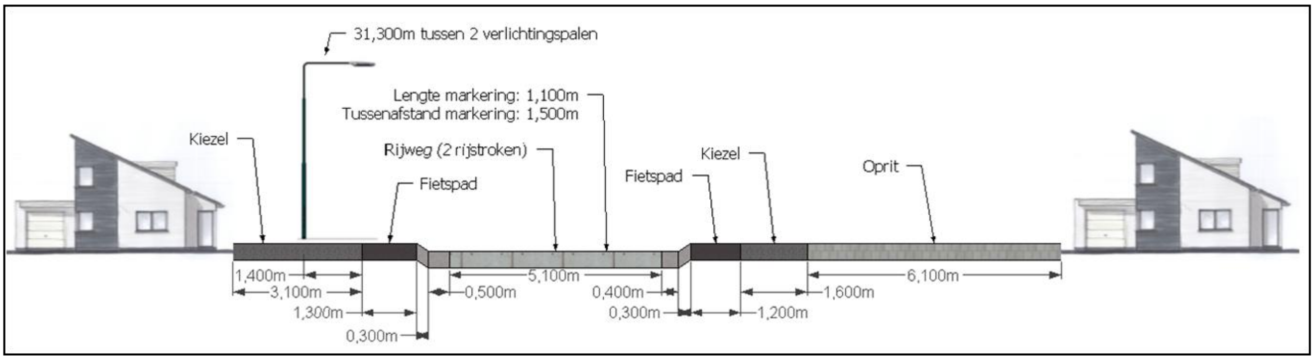
70 km/h (alongside of the canal)



70 km/h



<u>50 km/h</u>


31,300m tussen 2 verlichtingspalen
Lengte markering: 1,100m
Tussenafstand markering: 1,500m
Kiezel
Rijweg (2 rijstroken)
Fietspad
Fietspad
Kiezel
Oprit
1,400m
3,100m
1,300m
0,300m
5,100m
0,500m
0,400m
0,300m
1,600m
1,200m
6,100m

Appendix D

Below the questionnaire is presented that participants filled out before starting with the simulator experiment. This questionnaire includes some personal characteristics like date of birth, gender, etc.

Introductie

Studie: «Rijsimulatoronderzoek»

Geachte heer, mevrouw

Allereerst hartelijk dank om deel te nemen aan dit rijsimulatoronderzoek dat deel uitmaakt van mijn Masterproef Verkeerskunde – afstudeerrichting Verkeersveiligheid aan de Universiteit Hasselt, in samenwerking met het Instituut voor Mobiliteit.
Vooraleer van start te gaan met het onderzoek in de rijsimulator, is het van belang dat u deze informatie- en instructiebundel rustig en aandachtig doorneemt. Gelieve te wachten in het lokaal waar u zich momenteel bevindt totdat de onderzoeker u uitnodigt om plaats te nemen in de simulator. U kunt ondertussen gerust een drankje nemen.
In de volgende documenten zult u verdere informatie verkrijgen over het onderzoek en wordt u verzocht een instemmingsformulier te ondertekenen en vragenlijsten met deelnemersgegevens in te vullen.

Alvast bedankt!

Met vriendelijke groeten,
Joris Cornu

Deelnemersinformatie

Studie: «Rijsimulatoronderzoek»

U wordt uitgenodigd deel te nemen aan een onderzoek in een rijsimulator. Voordat u deelneemt aan dit onderzoek, is het belangrijk dat u weet wat dit inhoudt. Daarover informeren wij u graag in deze brief.
Het specifieke doel van dit onderzoek kan vooraf niet bekend worden gemaakt omdat bestuurders hun rijgedrag hierop kunnen afstemmen en zo de resultaten beïnvloeden. Wanneer alle deelnemers het onderzoek hebben afgelegd, wordt u op de hoogte gebracht van het doel van dit onderzoek.
Het onderzoek vindt plaats in een **rijsimulator**. Tijdens de ritten in de simulator zullen er gegevens worden verzameld met betrekking tot uw rijgedrag. Daarnaast zal er gevraagd worden om voor en na het simulatoronderzoek nog enkele vragen te beantwoorden. Alle gegevens die in deze studie verzameld worden, zullen **vertrouwelijk** en zonder herkenbare persoonsgegevens behandeld worden zoals bepaald in de «wet op de bescherming van persoonsgegevens, 1992».
Tijdens de deelname kan in enkele gevallen "simulatorziekte" optreden, gekenmerkt door duizeligheid, hoofdpijn of een ijl gevoel. Indien u deze symptomen herkent, wordt u gevraagd dit onmiddellijk aan de onderzoeker te melden. Daarnaast bent u te allen tijde vrij om het onderzoek te beëindigen.

Het onderzoek zal uitgevoerd worden door een masterstudent in de Verkeerskunde. Het onderzoek verloopt onder de supervisie van doctor Kris Brijs en doctoraatsstudent Caroline Ariën van het Instituut voor Mobiliteit.
De resultaten van het onderzoek zullen **wetenschappelijk gerapporteerd** worden in een masterproef en zullen mogelijk gepubliceerd worden in een vaktijdschrift. Indien u dit wenst, kan u na afloop van dit onderzoek een samenvattend verslag van de resultaten opvragen.
Indien u na het doornemen van deze informatie nog bijkomende vragen heeft, kan u deze zo dadelijk aan de onderzoeker stellen.

Toestemmingsformulier

Studie: «Rijsimulatoronderzoek»

Ik bevestig dat ik de schriftelijke informatie omtrent deze studie gelezen en begrepen heb en dat mijn vragen naar tevredenheid beantwoord zijn.
Ik bevestig dat mijn deelname volledig vrijwillig is en dat ik vrij ben om op elk moment uit de studie te stappen zonder een reden op te geven.
Ik bevestig dat ik geen informatie doorgeef aan derden.
Ik bevestig dat ik me zal gedragen zoals ik me normaal gedraag in het verkeer.
Ik begrijp dat de gegevens uit de vragenlijst op vertrouwelijke wijze verwerkt en gebruikt zullen worden.

…………………………	…………………………	…………………………
Naam van de deelnemer	Datum	Handtekening
…………………………	…………………………	…………………………
Naam van de onderzoeker	Datum	Handtekening

Deelnemersgegevens

Studie: «Rijsimulatoronderzoek»

1. Wat is uw geboortedatum?

   …………………………

2. Wat is uw geslacht?
   - □ Man
   - □ Vrouw
3. Bent u rechts- of linkshandig?
   - □ Rechtshandig
   - □ Linkshandig
4. Draagt u een bril of contactlenzen tijden het besturen van een wagen?
   - □ Ja
   - □ Nee
5. Welke types rijbewijs bezit u en sinds wanneer bent u in het bezit hiervan?

□ B	□ C	□ D
…………………………	…………………………	…………………………

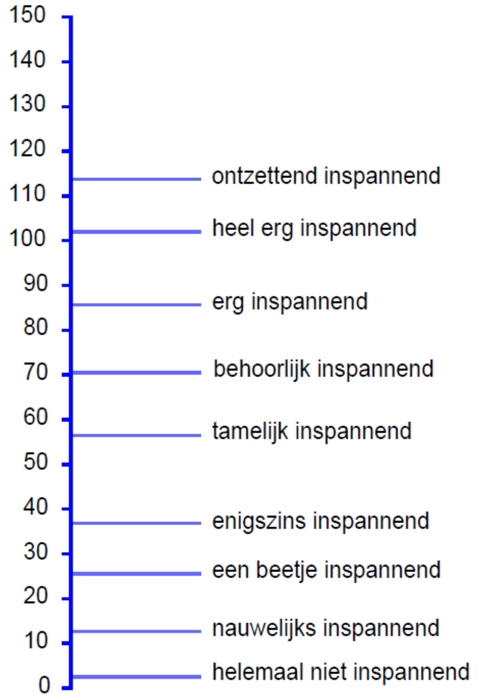
6. Wat is uw hoogst voltooide opleiding (met diploma)?
   □ Lager onderwijs
   □ Lager middelbaar onderwijs
   □ Hoger middelbaar onderwijs
   □ Hoger onderwijs, niet universitair
   □ Hoger onderwijs, universitair onderwijs
   □ Ander:…………………………
7. Wat is uw beroep?
   □ Bediende
   □ Arbeider
   □ Zelfstandige
   □ Student
   □ Niet beroepsmatig actief
   □ Ander:…………………………
8. Hoeveel kilometer rijdt u gemiddeld per jaar als bestuurder?
   □ 0 tot 4.999km
   □ 5.000 tot 9.999km
   □ 10.000 tot 14.999km
   □ 15.000 tot 19.999km
   □ 20.000 tot 25.000km
   □ Meer dan 25.000km
9. Waarvoor gebruikt u het vaakst de wagen?
   □ Woon-werkverkeer
   □ Professioneel
   □ Ontspanning
   □ Winkelen
   □ Ander: …………………………
10. Wanneer verplaatst u zich het vaakst?
[Spitsuren: van 07:00 tot 09:00 en van 16:30 tot 18:30]
   □ Buiten spitsuren
   □ Binnen spitsuren
11. Hoe vaak bent u als bestuurder betrokken geweest bij een ongeval?
   □ Nog nooit
   …………… keer met enkel materiële schade
   …………… keer met lichtgewonden
   …………… keer met zwaargewonden
   …………… keer met doden

Appendix E

Below the questionnaire is presented that participants filled out after they have finished the driving simulator tour. This questionnaire includes some questions about their driving behavior and the purpose of the research. At the end, participants were asked to give a score to twenty different messages projected on a screen. Below, these messages are all presented at the same time, but during the study messages were only shown one at a time (ordered randomly).

Post-bevraging

Wilt u door middel van het zetten van een streepje op onderstaande lijn aangeven hoeveel inspanning het u gekost heeft om deze rit in de rijsimulator uit te voeren (1e opwarmingsrit)



Wilt u door middel van het zetten van een streepje op onderstaande lijn aangeven hoeveel inspanning het u gekost heeft om deze rit in de rijsimulator uit te voeren (2e opwarmingsrit)

Wilt u door middel van het zetten van een streepje op onderstaande lijn aangeven hoeveel inspanning het u gekost heeft om deze rit in de rijsimulator uit te voeren (experimentele rit)

Vragenlijst

Studie: «Rijsimulatoronderzoek»

1. Wat is volgens u het doel van dit onderzoek?

……………………………………………………………………………………………

2. Bent u van mening dat de geldende snelheidslimieten tijdens de rit in de simulator in overeenstemming waren met de omgeving (m.a.w. ‘correct’ waren)?
 □ Ja
 □ Nee
3. Indien u nee antwoordde bij vraag 2, in welk(e) gedeelte(n) van de rit zou u de snelheidslimiet aanpassen?

………………………………………………………………………………………
4. Persoonlijk ben ik van mening dat mijn rijgedrag in de simulator in het algemeen
 □ Min of meer overeenkwam
 □ Enigszins afweek
 □ Sterk afweek
in vergelijking met mijn rijgedrag in de werkelijkheid.
5. Indien uw gedrag afweek, op welke punten week uw gedrag af?

………………………………………………………………………………………
6. Hebt u tijdens de rit één of meerdere digitale panelen langs de weg opgemerkt?
 □ Neen
 □ Ja
Indien ja, zou u kunnen beschrijven welke boodschap(pen) er werd(en) weergegeven op het bord?
………………………………………………………………………………………
Vanaf nu zullen we enkele vragen stellen in verband met digitale panelen die u in werkelijkheid naast de weg kan tegenkomen.
7. Denkt u dat de gemiddelde bestuurder de digitale panelen langs de weg nuttig vindt?
 □ Neen
 □ Ja
8. Denkt u dat de gemiddelde bestuurder zijn of haar rijgedrag aanpast op basis van de informatie die via digitale panelen wordt meegedeeld/weergegeven?
 □ Neen
 □ Ja
9. Denkt u dat de gemiddelde bestuurder digitale panelen duidelijker vindt dan de reguliere verkeersborden?
 □ Neen
 □ Ja
10. Komt het voor dat u te snel rijdt binnen de bebouwde kom? Met te snel rijden bedoelen we sneller dan de toegelaten limiet van 50 km/u.
 □ Zelden of nooit
 □ Soms
 □ Vaak
11. Komt het voor dat u te snel rijdt wanneer de snelheidslimiet 70 km/u is? Met te snel rijden bedoelen we sneller dan de toegelaten limiet van 70 km/u.
 □ Zelden of nooit
 □ Soms

□ Vaak

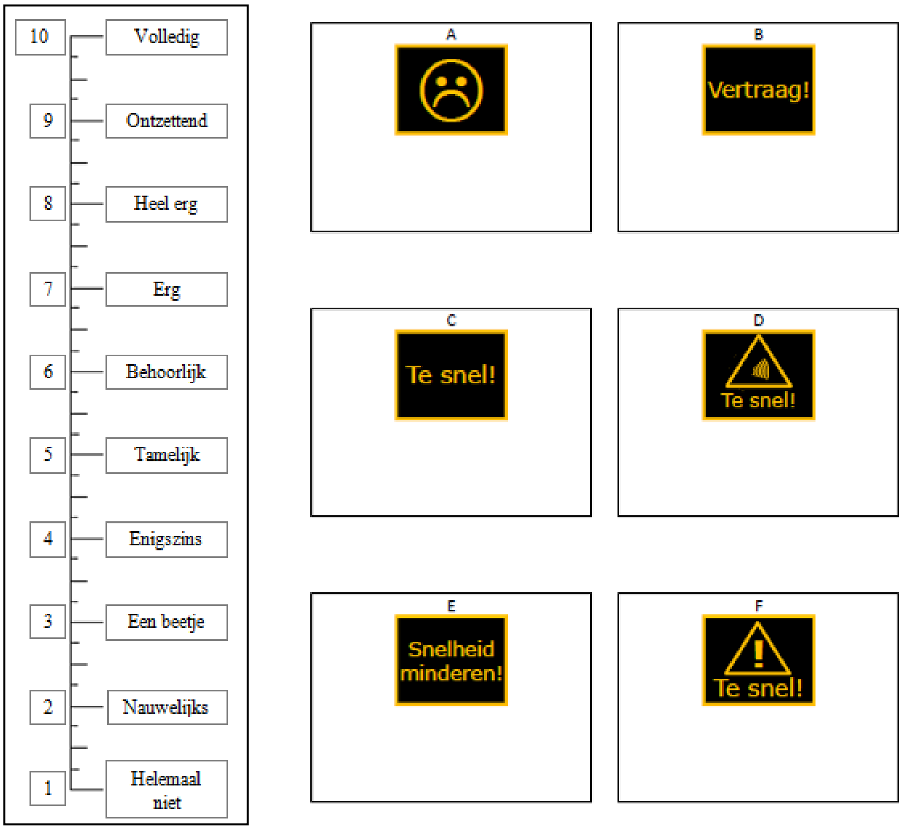
12. Komt het voor dat u te snel rijdt wanneer de snelheidslimiet 90 km/u is? Met te snel rijden bedoelen we sneller dan de toegelaten limiet van 90 km/u.
    □ Zelden of nooit
    □ Soms
    □ Vaak
13. Komt het voor dat u te snel rijdt op een autosnelweg? Met te snel rijden bedoelen we sneller dan de toegelaten limiet van 120 km/u.
    □ Zelden of nooit
    □ Soms
    □ Vaak
14. Hoe vaak heeft u afgelopen jaar een boete ontvangen voor een snelheidsovertreding?

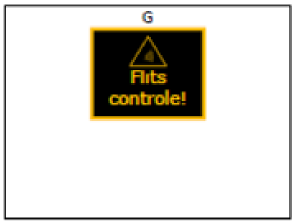
……………………………………………

Hierna zullen op het grote scherm een aantal mogelijke boodschappen worden geprojecteerd die weergegeven kunnen worden op digitale panelen wanneer een bestuurder te snel voorbij het bord rijdt.

15. In welke mate denkt u dat te snel rijdende bestuurders hun gedrag zullen aanpassen wanneer volgende boodschappen op een digitaal paneel worden afgebeeld?

Plaats een kruisje van ‘helemaal niet’ (= 1) tot ‘volledig’ (= 10) met een interval van 0,25. (twintig aparte schalen werden aan de proefpersoon gegeven)

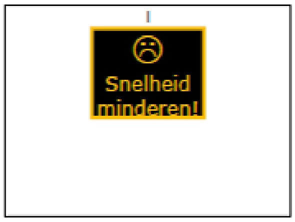



G
Flits
controle!


H
U rijdt
te snel!

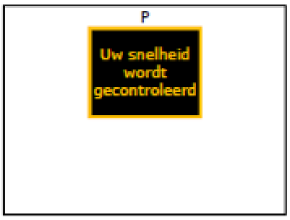

M
Boete
minstens
50 euro

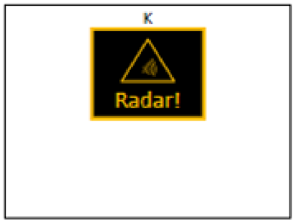

N
Te snel!


I
Snelheid
minderen!

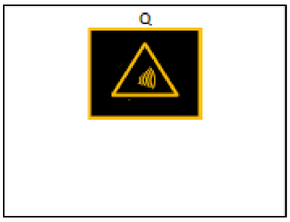

J
Let op je
teller!

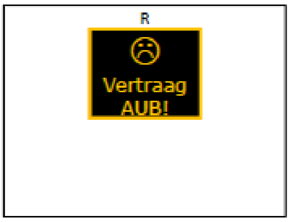

O
Uw snelheid
wordt
gemeten

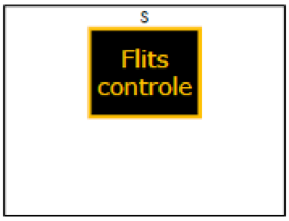

P
Uw snelheid
wordt
gecontroleerd


K
Radar!


L
U bent in
overtreding


Q


R
Vertraag
AUB!


S
Flits
controle


T
Snelheid
minderen!

Appendix F

This appendix presents the SPSS outputs concerning the analysis of the control zone (i.e. a zone of 500m that is situated 1750m before the digital display). This analysis was carried out to see whether significant differences exist between the four conditions. Under normal circumstances, no significant differences may exist because the measures don't have an influence at this distance.

Multivariate Tests[a]

Effect			Value	F	Hypothesis df	Error df	Sig.
Between Subjects	Intercept	Pillai's Trace	,994	2710,153[b]	4,000	61,000	,000
		Wilks' Lambda	,006	2710,153[b]	4,000	61,000	,000
		Hotelling's Trace	177,715	2710,153[b]	4,000	61,000	,000
		Roy's Largest Root	177,715	2710,153[b]	4,000	61,000	,000
	location	Pillai's Trace	,535	17,560[b]	4,000	61,000	,000
		Wilks' Lambda	,465	17,560[b]	4,000	61,000	,000
		Hotelling's Trace	1,151	17,560[b]	4,000	61,000	,000
		Roy's Largest Root	1,151	17,560[b]	4,000	61,000	,000
Within Subjects	condition	Pillai's Trace	,121	,606[b]	12,000	53,000	,827
		Wilks' Lambda	,879	,606[b]	12,000	53,000	,827
		Hotelling's Trace	,137	,606[b]	12,000	53,000	,827
		Roy's Largest Root	,137	,606[b]	12,000	53,000	,827
	condition * location	Pillai's Trace	,175	,934[b]	12,000	53,000	,521
		Wilks' Lambda	,825	,934[b]	12,000	53,000	,521
		Hotelling's Trace	,212	,934[b]	12,000	53,000	,521
		Roy's Largest Root	,212	,934[b]	12,000	53,000	,521

a. Design: Intercept + location
Within Subjects Design: condition

b. Exact statistic

Estimates

Measure	location	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
mean_speed	1	22,553	,344	21,867	23,239
	2	19,845	,333	19,179	20,510
SD_speed	1	,738	,056	,627	,849
	2	,548	,054	,440	,656
mean_AD	1	,004	,010	-,015	,024
	2	-,011	,010	-,030	,008
SD_AD	1	,228	,017	,193	,263
	2	,147	,017	,113	,181

Pairwise Comparisons

Measure	(I) location	(J) location	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
mean_speed	1	2	2,708*	,479	,000	1,752	3,665
	2	1	-2,708*	,479	,000	-3,665	-1,752
SD_speed	1	2	,190*	,077	,017	,035	,345
	2	1	-,190*	,077	,017	-,345	-,035
mean_AD	1	2	,016	,014	,263	-,012	,043
	2	1	-,016	,014	,263	-,043	,012
SD_AD	1	2	,081*	,024	,001	,033	,130
	2	1	-,081*	,024	,001	-,130	-,033

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Appendix G

This appendix presents the SPSS outputs concerning the analysis of six zones before the digital display.

Multivariate Tests[a]

Effect			Value	F	Hypothesis df	Error df	Sig.
Between Subjects	Intercept	Pillai's Trace	,997	4558,278[b]	4,000	61,000	,000
		Wilks' Lambda	,003	4558,278[b]	4,000	61,000	,000
		Hotelling's Trace	298,904	4558,278[b]	4,000	61,000	,000
		Roy's Largest Root	298,904	4558,278[b]	4,000	61,000	,000
	location	Pillai's Trace	,052	,831[b]	4,000	61,000	,511
		Wilks' Lambda	,948	,831[b]	4,000	61,000	,511
		Hotelling's Trace	,055	,831[b]	4,000	61,000	,511
		Roy's Largest Root	,055	,831[b]	4,000	61,000	,511
Within Subjects	Condition	Pillai's Trace	,562	5,678[b]	12,000	53,000	,000
		Wilks' Lambda	,438	5,678[b]	12,000	53,000	,000
		Hotelling's Trace	1,286	5,678[b]	12,000	53,000	,000
		Roy's Largest Root	1,286	5,678[b]	12,000	53,000	,000
	Condition * location	Pillai's Trace	,264	1,584[b]	12,000	53,000	,125
		Wilks' Lambda	,736	1,584[b]	12,000	53,000	,125
		Hotelling's Trace	,359	1,584[b]	12,000	53,000	,125
		Roy's Largest Root	,359	1,584[b]	12,000	53,000	,125
	Zone	Pillai's Trace	,811	9,684[b]	20,000	45,000	,000
		Wilks' Lambda	,189	9,684[b]	20,000	45,000	,000
		Hotelling's Trace	4,304	9,684[b]	20,000	45,000	,000
		Roy's Largest Root	4,304	9,684[b]	20,000	45,000	,000
	Zone * location	Pillai's Trace	,473	2,023[b]	20,000	45,000	,025
		Wilks' Lambda	,527	2,023[b]	20,000	45,000	,025
		Hotelling's Trace	,899	2,023[b]	20,000	45,000	,025
		Roy's Largest Root	,899	2,023[b]	20,000	45,000	,025
	Condition * Zone	Pillai's Trace	,989	7,247[b]	60,000	5,000	,017
		Wilks' Lambda	,011	7,247[b]	60,000	5,000	,017
		Hotelling's Trace	86,969	7,247[b]	60,000	5,000	,017
		Roy's Largest Root	86,969	7,247[b]	60,000	5,000	,017
	Condition * Zone * location	Pillai's Trace	,843	,449[b]	60,000	5,000	,937
		Wilks' Lambda	,157	,449[b]	60,000	5,000	,937
		Hotelling's Trace	5,388	,449[b]	60,000	5,000	,937
		Roy's Largest Root	5,388	,449[b]	60,000	5,000	,937

a. Design: Intercept + location
Within Subjects Design: Condition + Zone + Condition * Zone

b. Exact statistic

Univariate Tests

Source	Measure		Type III Sum of Squares	df	Mean Square	F	Sig.
Condition	mean_speed	Sphericity Assumed	21,466	3	7,155	3,227	,024
		Greenhouse-Geisser	21,466	2,702	7,945	3,227	,028
		Huynh-Feldt	21,466	2,876	7,463	3,227	,025
		Lower-bound	21,466	1,000	21,466	3,227	,077
	SD_speed	Sphericity Assumed	,706	3	,235	,674	,569
		Greenhouse-Geisser	,706	2,962	,238	,674	,567
		Huynh-Feldt	,706	3,000	,235	,674	,569
		Lower-bound	,706	1,000	,706	,674	,415
	mean_AD	Sphericity Assumed	,506	3	,169	6,123	,001
		Greenhouse-Geisser	,506	2,802	,181	6,123	,001
		Huynh-Feldt	,506	2,989	,169	6,123	,001
		Lower-bound	,506	1,000	,506	6,123	,016
	SD_AD	Sphericity Assumed	,349	3	,116	3,776	,012
		Greenhouse-Geisser	,349	2,859	,122	3,776	,013
		Huynh-Feldt	,349	3,000	,116	3,776	,012
		Lower-bound	,349	1,000	,349	3,776	,056
Condition * location	mean_speed	Sphericity Assumed	18,204	3	6,068	2,737	,045
		Greenhouse-Geisser	18,204	2,702	6,738	2,737	,051
		Huynh-Feldt	18,204	2,876	6,329	2,737	,047
		Lower-bound	18,204	1,000	18,204	2,737	,103
	SD_speed	Sphericity Assumed	,571	3	,190	,545	,652
		Greenhouse-Geisser	,571	2,962	,193	,545	,650
		Huynh-Feldt	,571	3,000	,190	,545	,652
		Lower-bound	,571	1,000	,571	,545	,463
	mean_AD	Sphericity Assumed	,132	3	,044	1,594	,192
		Greenhouse-Geisser	,132	2,802	,047	1,594	,195
		Huynh-Feldt	,132	2,989	,044	1,594	,192
		Lower-bound	,132	1,000	,132	1,594	,211
	SD_AD	Sphericity Assumed	,046	3	,015	,497	,685
		Greenhouse-Geisser	,046	2,859	,016	,497	,676
		Huynh-Feldt	,046	3,000	,015	,497	,685
		Lower-bound	,046	1,000	,046	,497	,483
Error(Condition)	mean_speed	Sphericity Assumed	425,718	192	2,217		
		Greenhouse-Geisser	425,718	172,917	2,462		
		Huynh-Feldt	425,718	184,092	2,313		
		Lower-bound	425,718	64,000	6,652		
	SD_speed	Sphericity Assumed	66,999	192	,349		
		Greenhouse-Geisser	66,999	189,573	,353		
		Huynh-Feldt	66,999	192,000	,349		
		Lower-bound	66,999	64,000	1,047		
	mean_AD	Sphericity Assumed	5,289	192	,028		
		Greenhouse-Geisser	5,289	179,309	,029		
		Huynh-Feldt	5,289	191,286	,028		
		Lower-bound	5,289	64,000	,083		
	SD_AD	Sphericity Assumed	5,922	192	,031		
		Greenhouse-Geisser	5,922	182,966	,032		
		Huynh-Feldt	5,922	192,000	,031		
		Lower-bound	5,922	64,000	,093		
Zone	mean_speed	Sphericity Assumed	2,624	5	,525	1,478	,197
		Greenhouse-Geisser	2,624	1,644	1,597	1,478	,234
		Huynh-Feldt	2,624	1,708	1,537	1,478	,233
		Lower-bound	2,624	1,000	2,624	1,478	,229

	SD_speed	Sphericity Assumed	17,688	5	3,538	55,972	,000
		Greenhouse-Geisser	17,688	2,909	6,081	55,972	,000
		Huynh-Feldt	17,688	3,109	5,688	55,972	,000
		Lower-bound	17,688	1,000	17,688	55,972	,000
	mean_AD	Sphericity Assumed	1,788	5	,358	10,349	,000
		Greenhouse-Geisser	1,788	2,898	,617	10,349	,000
		Huynh-Feldt	1,788	3,097	,577	10,349	,000
		Lower-bound	1,788	1,000	1,788	10,349	,002
	SD_AD	Sphericity Assumed	1,025	5	,205	10,144	,000
		Greenhouse-Geisser	1,025	2,642	,388	10,144	,000
		Huynh-Feldt	1,025	2,810	,365	10,144	,000
		Lower-bound	1,025	1,000	1,025	10,144	,002
Zone * location	mean_speed	Sphericity Assumed	1,810	5	,362	1,019	,406
		Greenhouse-Geisser	1,810	1,644	1,101	1,019	,352
		Huynh-Feldt	1,810	1,708	1,060	1,019	,354
		Lower-bound	1,810	1,000	1,810	1,019	,317
	SD_speed	Sphericity Assumed	,595	5	,119	1,881	,097
		Greenhouse-Geisser	,595	2,909	,204	1,881	,136
		Huynh-Feldt	,595	3,109	,191	1,881	,132
		Lower-bound	,595	1,000	,595	1,881	,175
	mean_AD	Sphericity Assumed	,752	5	,150	4,356	,001
		Greenhouse-Geisser	,752	2,898	,260	4,356	,006
		Huynh-Feldt	,752	3,097	,243	4,356	,005
		Lower-bound	,752	1,000	,752	4,356	,041
	SD_AD	Sphericity Assumed	,138	5	,028	1,368	,236
		Greenhouse-Geisser	,138	2,642	,052	1,368	,256
		Huynh-Feldt	,138	2,810	,049	1,368	,255
		Lower-bound	,138	1,000	,138	1,368	,246
Error(Zone)	mean_speed	Sphericity Assumed	113,630	320	,355		
		Greenhouse-Geisser	113,630	105,188	1,080		
		Huynh-Feldt	113,630	109,282	1,040		
		Lower-bound	113,630	64,000	1,775		
	SD_speed	Sphericity Assumed	20,225	320	,063		
		Greenhouse-Geisser	20,225	186,145	,109		
		Huynh-Feldt	20,225	199,006	,102		
		Lower-bound	20,225	64,000	,316		
	mean_AD	Sphericity Assumed	11,055	320	,035		
		Greenhouse-Geisser	11,055	185,466	,060		
		Huynh-Feldt	11,055	198,238	,056		
		Lower-bound	11,055	64,000	,173		
	SD_AD	Sphericity Assumed	6,466	320	,020		
		Greenhouse-Geisser	6,466	169,114	,038		
		Huynh-Feldt	6,466	179,824	,036		
		Lower-bound	6,466	64,000	,101		
Condition * Zone	mean_speed	Sphericity Assumed	8,915	15	,594	3,821	,000
		Greenhouse-Geisser	8,915	4,372	2,039	3,821	,004
		Huynh-Feldt	8,915	4,805	1,855	3,821	,003
		Lower-bound	8,915	1,000	8,915	3,821	,055
	SD_speed	Sphericity Assumed	,916	15	,061	1,223	,247
		Greenhouse-Geisser	,916	7,229	,127	1,223	,287
		Huynh-Feldt	,916	8,369	,109	1,223	,281
		Lower-bound	,916	1,000	,916	1,223	,273
	mean_AD	Sphericity Assumed	,332	15	,022	1,038	,413
		Greenhouse-Geisser	,332	8,101	,041	1,038	,406
		Huynh-Feldt	,332	9,530	,035	1,038	,409
		Lower-bound	,332	1,000	,332	1,038	,312

	SD_AD	Sphericity Assumed	,295	15	,020	1,647	,056
		Greenhouse-Geisser	,295	6,523	,045	1,647	,126
		Huynh-Feldt	,295	7,456	,040	1,647	,115
		Lower-bound	,295	1,000	,295	1,647	,204
Condition * Zone * location	mean_speed	Sphericity Assumed	4,789	15	,319	2,052	,010
		Greenhouse-Geisser	4,789	4,372	1,095	2,052	,081
		Huynh-Feldt	4,789	4,805	,997	2,052	,074
		Lower-bound	4,789	1,000	4,789	2,052	,157
	SD_speed	Sphericity Assumed	,822	15	,055	1,098	,354
		Greenhouse-Geisser	,822	7,229	,114	1,098	,364
		Huynh-Feldt	,822	8,369	,098	1,098	,363
		Lower-bound	,822	1,000	,822	1,098	,299
	mean_AD	Sphericity Assumed	,476	15	,032	1,486	,103
		Greenhouse-Geisser	,476	8,101	,059	1,486	,158
		Huynh-Feldt	,476	9,530	,050	1,486	,144
		Lower-bound	,476	1,000	,476	1,486	,227
	SD_AD	Sphericity Assumed	,275	15	,018	1,536	,086
		Greenhouse-Geisser	,275	6,523	,042	1,536	,159
		Huynh-Feldt	,275	7,456	,037	1,536	,148
		Lower-bound	,275	1,000	,275	1,536	,220
Error(Condition*Zone)	mean_speed	Sphericity Assumed	149,320	960	,156		
		Greenhouse-Geisser	149,320	279,788	,534		
		Huynh-Feldt	149,320	307,539	,486		
		Lower-bound	149,320	64,000	2,333		
	SD_speed	Sphericity Assumed	47,938	960	,050		
		Greenhouse-Geisser	47,938	462,648	,104		
		Huynh-Feldt	47,938	535,603	,090		
		Lower-bound	47,938	64,000	,749		
	mean_AD	Sphericity Assumed	20,475	960	,021		
		Greenhouse-Geisser	20,475	518,494	,039		
		Huynh-Feldt	20,475	609,902	,034		
		Lower-bound	20,475	64,000	,320		
	SD_AD	Sphericity Assumed	11,457	960	,012		
		Greenhouse-Geisser	11,457	417,490	,027		
		Huynh-Feldt	11,457	477,173	,024		
		Lower-bound	11,457	64,000	,179		

Appendix H

This appendix presents the SPSS outputs concerning the analysis of six zones before the digital display (interaction term Condition x Zone: separate tests for Condition).

Condition 1 (controle)

Estimates

Measure: MEASURE_1

zone	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	13,894	,163	13,568	14,220
2	13,903	,157	13,589	14,216
3	13,964	,151	13,663	14,265
4	13,992	,143	13,707	14,277
5	13,988	,138	13,712	14,263
6	14,107	,134	13,839	14,375

Pairwise Comparisons

Measure: MEASURE_1

(I) zone	(J) zone	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-,009	,033	,790	-,075	,058
	3	-,070	,058	,229	-,185	,045
	4	-,098	,071	,173	-,241	,044
	5	-,094	,078	,233	-,249	,062
	6	-,213	,107	,051	-,427	,001
2	1	,009	,033	,790	-,058	,075
	3	-,061*	,030	,044	-,120	-,002
	4	-,089	,049	,073	-,187	,009
	5	-,085	,061	,166	-,206	,036
	6	-,204*	,097	,040	-,398	-,010
3	1	,070	,058	,229	-,045	,185
	2	,061*	,030	,044	,002	,120
	4	-,029	,026	,283	-,081	,024
	5	-,024	,045	,595	-,114	,066
	6	-,143	,091	,120	-,325	,038
4	1	,098	,071	,173	-,044	,241
	2	,089	,049	,073	-,009	,187
	3	,029	,026	,283	-,024	,081
	5	,005	,025	,855	-,045	,055
	6	-,115	,078	,146	-,271	,041
5	1	,094	,078	,233	-,062	,249
	2	,085	,061	,166	-,036	,206
	3	,024	,045	,595	-,066	,114
	4	-,005	,025	,855	-,055	,045
	6	-,119	,060	,051	-,239	,001
6	1	,213	,107	,051	-,001	,427
	2	,204*	,097	,040	,010	,398
	3	,143	,091	,120	-,038	,325
	4	,115	,078	,146	-,041	,271
	5	,119	,060	,051	-,001	,239

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Condition 2 (smiley)

Estimates

Measure: MEASURE_1

zone	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	13,662	,158	13,346	13,979
2	13,663	,154	13,357	13,970
3	13,719	,145	13,429	14,009
4	13,769	,137	13,495	14,044
5	13,686	,132	13,422	13,949
6	13,682	,133	13,417	13,947

Pairwise Comparisons

Measure: MEASURE_1

(I) zone	(J) zone	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	-,001	,030	,966	-,060	,058
	3	-,057	,051	,267	-,158	,045
	4	-,107	,067	,116	-,242	,027
	5	-,024	,084	,778	-,191	,143
	6	-,020	,134	,882	-,288	,248
2	1	,001	,030	,966	-,058	,060
	3	-,056	,028	,055	-,112	,001
	4	-,106*	,052	,044	-,209	-,003
	5	-,022	,073	,760	-,168	,123
	6	-,019	,126	,882	-,270	,232
3	1	,057	,051	,267	-,045	,158
	2	,056	,028	,055	-,001	,112
	4	-,050	,027	,067	-,104	,004
	5	,033	,055	,549	-,077	,143
	6	,037	,114	,747	-,190	,264
4	1	,107	,067	,116	-,027	,242
	2	,106*	,052	,044	,003	,209
	3	,050	,027	,067	-,004	,104
	5	,084*	,037	,028	,009	,158
	6	,087	,101	,390	-,114	,288
5	1	,024	,084	,778	-,143	,191
	2	,022	,073	,760	-,123	,168
	3	-,033	,055	,549	-,143	,077
	4	-,084*	,037	,028	-,158	-,009
	6	,004	,075	,961	-,146	,153
6	1	,020	,134	,882	-,248	,288
	2	,019	,126	,882	-,232	,270
	3	-,037	,114	,747	-,264	,190
	4	-,087	,101	,390	-,288	,114
	5	-,004	,075	,961	-,153	,146

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Condition 3 (u rijdt te snel)

Estimates

Measure: MEASURE_1

zone	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	13,843	,152	13,540	14,146
2	13,803	,143	13,518	14,089
3	13,811	,138	13,535	14,087
4	13,833	,135	13,563	14,102
5	13,777	,134	13,509	14,045
6	13,656	,139	13,379	13,934

Pairwise Comparisons

Measure: MEASURE_1

(I) zone	(J) zone	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
1	2	,040	,037	,281	-,033	,113
	3	,032	,056	,568	-,080	,144
	4	,010	,071	,886	-,131	,152
	5	,066	,079	,405	-,092	,224
	6	,187	,139	,184	-,091	,464
2	1	-,040	,037	,281	-,113	,033
	3	-,008	,025	,765	-,058	,043
	4	-,030	,047	,531	-,123	,064
	5	,027	,064	,680	-,102	,155
	6	,147	,129	,261	-,112	,405
3	1	-,032	,056	,568	-,144	,080
	2	,008	,025	,765	-,043	,058
	4	-,022	,029	,445	-,079	,035
	5	,034	,053	,522	-,072	,140
	6	,154	,123	,212	-,090	,399
4	1	-,010	,071	,886	-,152	,131
	2	,030	,047	,531	-,064	,123
	3	,022	,029	,445	-,035	,079
	5	,056	,032	,088	-,009	,121
	6	,176	,109	,110	-,041	,394
5	1	-,066	,079	,405	-,224	,092
	2	-,027	,064	,680	-,155	,102
	3	-,034	,053	,522	-,140	,072
	4	-,056	,032	,088	-,121	,009
	6	,120	,092	,194	-,063	,303
6	1	-,187	,139	,184	-,464	,091
	2	-,147	,129	,261	-,405	,112
	3	-,154	,123	,212	-,399	,090
	4	-,176	,109	,110	-,394	,041
	5	-,120	,092	,194	-,303	,063

Based on estimated marginal means

a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Condition 4 (flitscontrole)

Estimates

Measure: MEASURE_1

zone	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
1	13,778	,158	13,463	14,092
2	13,748	,147	13,454	14,042
3	13,765	,133	13,499	14,030
4	13,766	,122	13,522	14,011
5	13,631	,139	13,353	13,909
6	13,395	,139	13,118	13,672

Pairwise Comparisons

Measure: MEASURE_1

(I) zone	(J) zone	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	,029	,034	,393	-,039	,097
	3	,013	,067	,845	-,120	,146
	4	,011	,087	,898	-,163	,185
	5	,146	,121	,231	-,095	,388
	6	,383*	,140	,008	,103	,662
2	1	-,029	,034	,393	-,097	,039
	3	-,016	,039	,677	-,094	,061
	4	-,018	,063	,773	-,143	,107
	5	,117	,109	,287	-,101	,335
	6	,353*	,128	,007	,098	,609
3	1	-,013	,067	,845	-,146	,120
	2	,016	,039	,677	-,061	,094
	4	-,002	,032	,953	-,065	,061
	5	,133	,095	,163	-,055	,322
	6	,370*	,116	,002	,139	,601
4	1	-,011	,087	,898	-,185	,163
	2	,018	,063	,773	-,107	,143
	3	,002	,032	,953	-,061	,065
	5	,135	,073	,067	-,010	,280
	6	,372*	,098	,000	,176	,567
5	1	-,146	,121	,231	-,388	,095
	2	-,117	,109	,287	-,335	,101
	3	-,133	,095	,163	-,322	,055
	4	-,135	,073	,067	-,280	,010
	6	,236*	,054	,000	,129	,343
6	1	-,383*	,140	,008	-,662	-,103
	2	-,353*	,128	,007	-,609	-,098
	3	-,370*	,116	,002	-,601	-,139
	4	-,372*	,098	,000	-,567	-,176
	5	-,236*	,054	,000	-,343	-,129

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Appendix I

This appendix presents the SPSS outputs concerning the analysis of six zones before the digital display (interaction term Condition x Zone: separate tests for Zone). No significant effects were revealed in zones one until four, therefore only the outputs of zones five and six are presented below.

Zone 5

Estimates

Measure: MEASURE_1

condition	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	13,988	,138	13,712	14,263
2	13,686	,132	13,422	13,949
3	13,777	,134	13,509	14,045
4	13,631	,139	13,353	13,909

Pairwise Comparisons

Measure: MEASURE_1

(I) condition	(J) condition	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	,302*	,101	,025	,026	,578
	3	,211	,103	,269	-,070	,491
	4	,356	,132	,053	-,003	,716
2	1	-,302*	,101	,025	-,578	-,026
	3	-,091	,116	1,000	-,407	,225
	4	,054	,150	1,000	-,354	,463
3	1	-,211	,103	,269	-,491	,070
	2	,091	,116	1,000	-,225	,407
	4	,146	,128	1,000	-,202	,493
4	1	-,356	,132	,053	-,716	,003
	2	-,054	,150	1,000	-,463	,354
	3	-,146	,128	1,000	-,493	,202

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Zone 6

Estimates

Measure: MEASURE_1

condition	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	14,107	,134	13,839	14,375
2	13,682	,133	13,417	13,947
3	13,656	,139	13,379	13,934
4	13,395	,139	13,118	13,672

Pairwise Comparisons

Measure: MEASURE_1

(I) condition	(J) condition	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1	2	,425*	,137	,017	,053	,797
	3	,450*	,144	,016	,057	,844
	4	,712*	,140	,000	,332	1,092
2	1	-,425*	,137	,017	-,797	-,053
	3	,026	,146	1,000	-,371	,422
	4	,287	,158	,437	-,141	,716
3	1	-,450*	,144	,016	-,844	-,057
	2	-,026	,146	1,000	-,422	,371
	4	,262	,145	,451	-,132	,655
4	1	-,712*	,140	,000	-1,092	-,332
	2	-,287	,158	,437	-,716	,141
	3	-,262	,145	,451	-,655	,132

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Appendix J

This appendix presents the SPSS outputs concerning the analysis of six zones after the digital display.

Multivariate Tests[a]

Effect			Value	F	Hypothesis df	Error df	Sig.
Between Subjects	Intercept	Pillai's Trace	,998	7173,995[b]	4,000	61,000	,000
		Wilks' Lambda	,002	7173,995[b]	4,000	61,000	,000
		Hotelling's Trace	470,426	7173,995[b]	4,000	61,000	,000
		Roy's Largest Root	470,426	7173,995[b]	4,000	61,000	,000
	location	Pillai's Trace	,125	2,188[b]	4,000	61,000	,081
		Wilks' Lambda	,875	2,188[b]	4,000	61,000	,081
		Hotelling's Trace	,143	2,188[b]	4,000	61,000	,081
		Roy's Largest Root	,143	2,188[b]	4,000	61,000	,081
Within Subjects	condition	Pillai's Trace	,588	6,291[b]	12,000	53,000	,000
		Wilks' Lambda	,412	6,291[b]	12,000	53,000	,000
		Hotelling's Trace	1,424	6,291[b]	12,000	53,000	,000
		Roy's Largest Root	1,424	6,291[b]	12,000	53,000	,000
	condition * location	Pillai's Trace	,261	1,556[b]	12,000	53,000	,134
		Wilks' Lambda	,739	1,556[b]	12,000	53,000	,134
		Hotelling's Trace	,352	1,556[b]	12,000	53,000	,134
		Roy's Largest Root	,352	1,556[b]	12,000	53,000	,134
	zone	Pillai's Trace	,568	2,960[b]	20,000	45,000	,001
		Wilks' Lambda	,432	2,960[b]	20,000	45,000	,001
		Hotelling's Trace	1,315	2,960[b]	20,000	45,000	,001
		Roy's Largest Root	1,315	2,960[b]	20,000	45,000	,001
	zone * location	Pillai's Trace	,358	1,255[b]	20,000	45,000	,258
		Wilks' Lambda	,642	1,255[b]	20,000	45,000	,258
		Hotelling's Trace	,558	1,255[b]	20,000	45,000	,258
		Roy's Largest Root	,558	1,255[b]	20,000	45,000	,258
	condition * zone	Pillai's Trace	,954	1,738[b]	60,000	5,000	,281
		Wilks' Lambda	,046	1,738[b]	60,000	5,000	,281
		Hotelling's Trace	20,856	1,738[b]	60,000	5,000	,281
		Roy's Largest Root	20,856	1,738[b]	60,000	5,000	,281
	condition * zone * location	Pillai's Trace	,940	1,314[b]	60,000	5,000	,418
		Wilks' Lambda	,060	1,314[b]	60,000	5,000	,418
		Hotelling's Trace	15,772	1,314[b]	60,000	5,000	,418
		Roy's Largest Root	15,772	1,314[b]	60,000	5,000	,418

a. Design: Intercept + location
Within Subjects Design: condition + zone + condition * zone

b. Exact statistic

Univariate Tests

Source	Measure		Type III Sum of Squares	df	Mean Square	F	Sig.
condition	mean_speed	Sphericity Assumed	91,283	3	30,428	10,706	,000
		Greenhouse-Geisser	91,283	2,916	31,304	10,706	,000
		Huynh-Feldt	91,283	3,000	30,428	10,706	,000
		Lower-bound	91,283	1,000	91,283	10,706	,002
	SD_speed	Sphericity Assumed	,028	3	,009	1,105	,348
		Greenhouse-Geisser	,028	2,855	,010	1,105	,347
		Huynh-Feldt	,028	3,000	,009	1,105	,348
		Lower-bound	,028	1,000	,028	1,105	,297
	mean_AD	Sphericity Assumed	,224	3	,075	2,299	,079
		Greenhouse-Geisser	,224	2,838	,079	2,299	,082
		Huynh-Feldt	,224	3,000	,075	2,299	,079
		Lower-bound	,224	1,000	,224	2,299	,134
	SD_AD	Sphericity Assumed	,010	3	,003	,699	,554
		Greenhouse-Geisser	,010	2,730	,004	,699	,541
		Huynh-Feldt	,010	2,908	,003	,699	,550
		Lower-bound	,010	1,000	,010	,699	,406
condition * location	mean_speed	Sphericity Assumed	15,646	3	5,215	1,835	,142
		Greenhouse-Geisser	15,646	2,916	5,366	1,835	,144
		Huynh-Feldt	15,646	3,000	5,215	1,835	,142
		Lower-bound	15,646	1,000	15,646	1,835	,180
	SD_speed	Sphericity Assumed	,008	3	,003	,321	,811
		Greenhouse-Geisser	,008	2,855	,003	,321	,801
		Huynh-Feldt	,008	3,000	,003	,321	,811
		Lower-bound	,008	1,000	,008	,321	,573
	mean_AD	Sphericity Assumed	,282	3	,094	2,893	,037
		Greenhouse-Geisser	,282	2,838	,099	2,893	,039
		Huynh-Feldt	,282	3,000	,094	2,893	,037
		Lower-bound	,282	1,000	,282	2,893	,094
	SD_AD	Sphericity Assumed	,017	3	,006	1,240	,296
		Greenhouse-Geisser	,017	2,730	,006	1,240	,296
		Huynh-Feldt	,017	2,908	,006	1,240	,296
		Lower-bound	,017	1,000	,017	1,240	,270
Error(condition)	mean_speed	Sphericity Assumed	545,701	192	2,842		
		Greenhouse-Geisser	545,701	186,629	2,924		
		Huynh-Feldt	545,701	192,000	2,842		
		Lower-bound	545,701	64,000	8,527		
	SD_speed	Sphericity Assumed	1,650	192	,009		
		Greenhouse-Geisser	1,650	182,721	,009		
		Huynh-Feldt	1,650	192,000	,009		
		Lower-bound	1,650	64,000	,026		
	mean_AD	Sphericity Assumed	6,241	192	,033		
		Greenhouse-Geisser	6,241	181,607	,034		
		Huynh-Feldt	6,241	192,000	,033		
		Lower-bound	6,241	64,000	,098		
	SD_AD	Sphericity Assumed	,902	192	,005		
		Greenhouse-Geisser	,902	174,739	,005		
		Huynh-Feldt	,902	186,140	,005		
		Lower-bound	,902	64,000	,014		
zone	mean_speed	Sphericity Assumed	13,682	5	2,736	9,437	,000
		Greenhouse-Geisser	13,682	1,375	9,948	9,437	,001
		Huynh-Feldt	13,682	1,418	9,652	9,437	,001
		Lower-bound	13,682	1,000	13,682	9,437	,003

		Lower-bound	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	SD_speed	Sphericity Assumed	,053	5	,011	2,841	,016
		Greenhouse-Geisser	,053	2,577	,021	2,841	,048
		Huynh-Feldt	,053	2,737	,019	2,841	,044
		Lower-bound	,053	1,000	,053	2,841	,097
	mean_AD	Sphericity Assumed	,540	5	,108	3,972	,002
		Greenhouse-Geisser	,540	2,613	,207	3,972	,012
		Huynh-Feldt	,540	2,777	,194	3,972	,011
		Lower-bound	,540	1,000	,540	3,972	,051
	SD_AD	Sphericity Assumed	,129	5	,026	7,001	,000
		Greenhouse-Geisser	,129	3,001	,043	7,001	,000
		Huynh-Feldt	,129	3,214	,040	7,001	,000
		Lower-bound	,129	1,000	,129	7,001	,010
zone * location	mean_speed	Sphericity Assumed	5,577	5	1,115	3,847	,002
		Greenhouse-Geisser	5,577	1,375	4,055	3,847	,040
		Huynh-Feldt	5,577	1,418	3,934	3,847	,039
		Lower-bound	5,577	1,000	5,577	3,847	,054
	SD_speed	Sphericity Assumed	,019	5	,004	1,041	,394
		Greenhouse-Geisser	,019	2,577	,008	1,041	,369
		Huynh-Feldt	,019	2,737	,007	1,041	,372
		Lower-bound	,019	1,000	,019	1,041	,311
	mean_AD	Sphericity Assumed	,254	5	,051	1,869	,099
		Greenhouse-Geisser	,254	2,613	,097	1,869	,145
		Huynh-Feldt	,254	2,777	,091	1,869	,141
		Lower-bound	,254	1,000	,254	1,869	,176
	SD_AD	Sphericity Assumed	,039	5	,008	2,097	,066
		Greenhouse-Geisser	,039	3,001	,013	2,097	,102
		Huynh-Feldt	,039	3,214	,012	2,097	,097
		Lower-bound	,039	1,000	,039	2,097	,152
Error(zone)	mean_speed	Sphericity Assumed	92,790	320	,290		
		Greenhouse-Geisser	92,790	88,023	1,054		
		Huynh-Feldt	92,790	90,723	1,023		
		Lower-bound	92,790	64,000	1,450		
	SD_speed	Sphericity Assumed	1,193	320	,004		
		Greenhouse-Geisser	1,193	164,947	,007		
		Huynh-Feldt	1,193	175,155	,007		
		Lower-bound	1,193	64,000	,019		
	mean_AD	Sphericity Assumed	8,700	320	,027		
		Greenhouse-Geisser	8,700	167,255	,052		
		Huynh-Feldt	8,700	177,740	,049		
		Lower-bound	8,700	64,000	,136		
	SD_AD	Sphericity Assumed	1,177	320	,004		
		Greenhouse-Geisser	1,177	192,039	,006		
		Huynh-Feldt	1,177	205,683	,006		
		Lower-bound	1,177	64,000	,018		
condition * zone	mean_speed	Sphericity Assumed	2,971	15	,198	1,760	,036
		Greenhouse-Geisser	2,971	4,418	,672	1,760	,130
		Huynh-Feldt	2,971	4,860	,611	1,760	,123
		Lower-bound	2,971	1,000	2,971	1,760	,189
	SD_speed	Sphericity Assumed	,053	15	,004	1,507	,096
		Greenhouse-Geisser	,053	7,496	,007	1,507	,157
		Huynh-Feldt	,053	8,720	,006	1,507	,145
		Lower-bound	,053	1,000	,053	1,507	,224
	mean_AD	Sphericity Assumed	,123	15	,008	,464	,958
		Greenhouse-Geisser	,123	7,266	,017	,464	,867
		Huynh-Feldt	,123	8,418	,015	,464	,889
		Lower-bound	,123	1,000	,123	,464	,498

	SD_AD	Sphericity Assumed	,055	15	,004	1,112	,340
		Greenhouse-Geisser	,055	8,362	,007	1,112	,353
		Huynh-Feldt	,055	9,884	,006	1,112	,350
		Lower-bound	,055	1,000	,055	1,112	,296
condition * zone * location	mean_speed	Sphericity Assumed	2,934	15	,196	1,738	,039
		Greenhouse-Geisser	2,934	4,418	,664	1,738	,135
		Huynh-Feldt	2,934	4,860	,604	1,738	,128
		Lower-bound	2,934	1,000	2,934	1,738	,192
	SD_speed	Sphericity Assumed	,052	15	,003	1,472	,108
		Greenhouse-Geisser	,052	7,496	,007	1,472	,170
		Huynh-Feldt	,052	8,720	,006	1,472	,157
		Lower-bound	,052	1,000	,052	1,472	,229
	mean_AD	Sphericity Assumed	,330	15	,022	1,243	,233
		Greenhouse-Geisser	,330	7,266	,045	1,243	,276
		Huynh-Feldt	,330	8,418	,039	1,243	,269
		Lower-bound	,330	1,000	,330	1,243	,269
	SD_AD	Sphericity Assumed	,064	15	,004	1,291	,201
		Greenhouse-Geisser	,064	8,362	,008	1,291	,243
		Huynh-Feldt	,064	9,884	,006	1,291	,232
		Lower-bound	,064	1,000	,064	1,291	,260
Error(condition*zone)	mean_speed	Sphericity Assumed	108,051	960	,113		
		Greenhouse-Geisser	108,051	282,748	,382		
		Huynh-Feldt	108,051	311,056	,347		
		Lower-bound	108,051	64,000	1,688		
	SD_speed	Sphericity Assumed	2,260	960	,002		
		Greenhouse-Geisser	2,260	479,749	,005		
		Huynh-Feldt	2,260	558,111	,004		
		Lower-bound	2,260	64,000	,035		
	mean_AD	Sphericity Assumed	16,985	960	,018		
		Greenhouse-Geisser	16,985	465,037	,037		
		Huynh-Feldt	16,985	538,734	,032		
		Lower-bound	16,985	64,000	,265		
	SD_AD	Sphericity Assumed	3,149	960	,003		
		Greenhouse-Geisser	3,149	535,189	,006		
		Huynh-Feldt	3,149	632,565	,005		
		Lower-bound	3,149	64,000	,049		

Estimates

Measure	condition	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
mean_speed	1	13,875	,139	13,597	14,154
	2	13,584	,121	13,343	13,826
	3	13,450	,107	13,235	13,664
	4	13,211	,099	13,013	13,408
SD_speed	1	,060	,006	,049	,071
	2	,071	,008	,055	,086
	3	,066	,005	,056	,077
	4	,061	,006	,050	,073
mean_AD	1	-,050	,012	-,073	-,026
	2	-,026	,011	-,048	-,003
	3	-,037	,012	-,061	-,014
	4	-,018	,009	-,036	,000
SD_AD	1	,038	,004	,029	,047
	2	,044	,006	,033	,055
	3	,043	,004	,035	,051
	4	,040	,004	,032	,048

Estimates

Measure	zone	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
mean_speed	1	13,639	,097	13,445	13,832
	2	13,611	,093	13,426	13,796
	3	13,564	,092	13,380	13,748
	4	13,528	,092	13,344	13,713
	5	13,481	,097	13,288	13,674
	6	13,357	,109	13,140	13,574
SD_speed	1	,072	,005	,061	,083
	2	,061	,005	,051	,070
	3	,059	,004	,050	,067
	4	,059	,005	,049	,069
	5	,065	,007	,050	,079
	6	,073	,007	,059	,086
mean_AD	1	-,023	,012	-,046	,001
	2	-,020	,010	-,040	-,001
	3	-,027	,011	-,049	-,005
	4	-,012	,012	-,036	,011
	5	-,048	,013	-,075	-,021
	6	-,066	,014	-,094	-,038
SD_AD	1	,041	,004	,033	,049
	2	,038	,004	,030	,046
	3	,032	,003	,025	,038
	4	,031	,004	,023	,039
	5	,050	,006	,039	,061
	6	,056	,007	,041	,070

Appendix K

This appendix presents the SPSS outputs concerning the analysis of six zones after the roundabout (distance halo effect).

Multivariate Tests[a]

Effect			Value	F	Hypothesis df	Error df	Sig.
Between Subjects	Intercept	Pillai's Trace	,996	3796,418[b]	4,000	61,000	,000
		Wilks' Lambda	,004	3796,418[b]	4,000	61,000	,000
		Hotelling's Trace	248,945	3796,418[b]	4,000	61,000	,000
		Roy's Largest Root	248,945	3796,418[b]	4,000	61,000	,000
	location	Pillai's Trace	,071	1,163[b]	4,000	61,000	,336
		Wilks' Lambda	,929	1,163[b]	4,000	61,000	,336
		Hotelling's Trace	,076	1,163[b]	4,000	61,000	,336
		Roy's Largest Root	,076	1,163[b]	4,000	61,000	,336
Within Subjects	condition	Pillai's Trace	,200	1,102[b]	12,000	53,000	,378
		Wilks' Lambda	,800	1,102[b]	12,000	53,000	,378
		Hotelling's Trace	,250	1,102[b]	12,000	53,000	,378
		Roy's Largest Root	,250	1,102[b]	12,000	53,000	,378
	condition * location	Pillai's Trace	,155	,810[b]	12,000	53,000	,639
		Wilks' Lambda	,845	,810[b]	12,000	53,000	,639
		Hotelling's Trace	,183	,810[b]	12,000	53,000	,639
		Roy's Largest Root	,183	,810[b]	12,000	53,000	,639
	zone	Pillai's Trace	,993	322,282[b]	20,000	45,000	,000
		Wilks' Lambda	,007	322,282[b]	20,000	45,000	,000
		Hotelling's Trace	143,236	322,282[b]	20,000	45,000	,000
		Roy's Largest Root	143,236	322,282[b]	20,000	45,000	,000
	zone * location	Pillai's Trace	,401	1,504[b]	20,000	45,000	,127
		Wilks' Lambda	,599	1,504[b]	20,000	45,000	,127
		Hotelling's Trace	,669	1,504[b]	20,000	45,000	,127
		Roy's Largest Root	,669	1,504[b]	20,000	45,000	,127
	condition * zone	Pillai's Trace	,940	1,307[b]	60,000	5,000	,421
		Wilks' Lambda	,060	1,307[b]	60,000	5,000	,421
		Hotelling's Trace	15,682	1,307[b]	60,000	5,000	,421
		Roy's Largest Root	15,682	1,307[b]	60,000	5,000	,421
	condition * zone * location	Pillai's Trace	,945	1,433[b]	60,000	5,000	,373
		Wilks' Lambda	,055	1,433[b]	60,000	5,000	,373
		Hotelling's Trace	17,198	1,433[b]	60,000	5,000	,373
		Roy's Largest Root	17,198	1,433[b]	60,000	5,000	,373

a. Design: Intercept + location
Within Subjects Design: condition + zone + condition * zone

b. Exact statistic

Estimates

Measure	zone	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
mean_speed	1	6,288	,137	6,015	6,561
	2	10,575	,145	10,286	10,864
	3	12,463	,146	12,171	12,755
	4	13,454	,130	13,193	13,714
	5	13,849	,123	13,603	14,095
	6	13,852	,126	13,600	14,105
SD_speed	1	1,224	,058	1,109	1,340
	2	,831	,029	,774	,888
	3	,436	,018	,399	,473
	4	,253	,015	,222	,283
	5	,183	,012	,160	,206
	6	,143	,014	,115	,171
mean_AD	1	,371	,019	,333	,408
	2	,591	,022	,547	,636
	3	,329	,017	,294	,363
	4	,175	,016	,142	,208
	5	,055	,014	,026	,083
	6	-,014	,010	-,035	,007
SD_AD	1	,650	,037	,577	,723
	2	,323	,018	,287	,359
	3	,233	,015	,203	,264
	4	,146	,012	,123	,169
	5	,104	,009	,086	,121
	6	,081	,008	,065	,096

Appendix L

This appendix presents the SPSS outputs concerning the analysis of the postal survey.

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
digital_display	Pillai's Trace	,710	15,251[b]	9,000	56,000	,000
	Wilks' Lambda	,290	15,251[b]	9,000	56,000	,000
	Hotelling's Trace	2,451	15,251[b]	9,000	56,000	,000
	Roy's Largest Root	2,451	15,251[b]	9,000	56,000	,000
digital_display * Location	Pillai's Trace	,162	1,202[b]	9,000	56,000	,312
	Wilks' Lambda	,838	1,202[b]	9,000	56,000	,312
	Hotelling's Trace	,193	1,202[b]	9,000	56,000	,312
	Roy's Largest Root	,193	1,202[b]	9,000	56,000	,312

a. Design: Intercept + Location
Within Subjects Design: digital_display

b. Exact statistic

Estimates

Measure: MEASURE_1

digital_display	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	6,528	,199	6,132	6,925
2	7,057	,199	6,660	7,453
3	6,728	,189	6,350	7,106
4	8,017	,163	7,691	8,344
5	7,448	,220	7,009	7,888
6	6,994	,201	6,593	7,394
7	7,299	,245	6,810	7,788
8	7,710	,222	7,267	8,154
9	6,791	,213	6,365	7,217
10	7,785	,170	7,445	8,124

Pairwise Comparisons

Measure: MEASURE_1

(I) digital_display	(J) digital_display	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	95% Confidence Interval for Difference[b] Upper Bound
1	2	-,528*	,117	,000	-,762	-,295
	3	-,199	,197	,315	-,593	,194
	4	-1,489*	,210	,000	-1,908	-1,070
	5	-,920*	,188	,000	-1,296	-,543
	6	-,465*	,231	,048	-,926	-,005
	7	-,770*	,226	,001	-1,221	-,319
	8	-1,182*	,196	,000	-1,573	-,790
	9	-,262	,229	,257	-,721	,196
	10	-1,256*	,213	,000	-1,682	-,831
2	1	,528*	,117	,000	,295	,762
	3	,329	,201	,108	-,074	,731
	4	-,961*	,182	,000	-1,324	-,597
	5	-,392	,206	,061	-,802	,019
	6	,063	,200	,754	-,337	,462
	7	-,242	,227	,291	-,696	,212
	8	-,653*	,195	,001	-1,043	-,264
	9	,266	,198	,184	-,130	,662
	10	-,728*	,191	,000	-1,110	-,346

3	1	,199	,197	,315	-,194	,593
	2	-,329	,201	,108	-,731	,074
	4	-1,290*	,188	,000	-1,665	-,914
	5	-,720*	,229	,003	-1,178	-,262
	6	-,266	,253	,297	-,771	,239
	7	-,571*	,259	,031	-1,089	-,053
	8	-,982*	,242	,000	-1,466	-,499
	9	-,063	,234	,790	-,530	,405
	10	-1,057*	,201	,000	-1,459	-,655
4	1	1,489*	,210	,000	1,070	1,908
	2	,961*	,182	,000	,597	1,324
	3	1,290*	,188	,000	,914	1,665
	5	,569*	,215	,010	,140	,998
	6	1,024*	,154	,000	,717	1,330
	7	,719*	,210	,001	,298	1,139
	8	,307	,216	,159	-,124	,738
	9	1,227*	,175	,000	,877	1,577
	10	,233	,127	,071	-,020	,486
5	1	,920*	,188	,000	,543	1,296
	2	,392	,206	,061	-,019	,802
	3	,720*	,229	,003	,262	1,178
	4	-,569*	,215	,010	-,998	-,140
	6	,455	,256	,081	-,058	,967
	7	,149	,206	,470	-,262	,560
	8	-,262	,253	,304	-,767	,243
	9	,658*	,242	,008	,175	1,140
	10	-,336	,209	,112	-,754	,081
6	1	,465*	,231	,048	,005	,926
	2	-,063	,200	,754	-,462	,337
	3	,266	,253	,297	-,239	,771
	4	-1,024*	,154	,000	-1,330	-,717
	5	-,455	,256	,081	-,967	,058
	7	-,305	,241	,211	-,787	,177
	8	-,716*	,258	,007	-1,232	-,201
	9	,203	,202	,320	-,201	,608
	10	-,791*	,182	,000	-1,154	-,427
7	1	,770*	,226	,001	,319	1,221
	2	,242	,227	,291	-,212	,696
	3	,571*	,259	,031	,053	1,089
	4	-,719*	,210	,001	-1,139	-,298
	5	-,149	,206	,470	-,560	,262
	6	,305	,241	,211	-,177	,787
	8	-,411	,221	,068	-,853	,031
	9	,508*	,250	,046	,010	1,007
	10	-,486*	,203	,020	-,892	-,080
8	1	1,182*	,196	,000	,790	1,573
	2	,653*	,195	,001	,264	1,043
	3	,982*	,242	,000	,499	1,466
	4	-,307	,216	,159	-,738	,124
	5	,262	,253	,304	-,243	,767
	6	,716*	,258	,007	,201	1,232
	7	,411	,221	,068	-,031	,853
	9	,920*	,228	,000	,465	1,374
	10	-,074	,219	,735	-,512	,363

9	1	,262	,229	,257	-,196	,721
	2	-,266	,198	,184	-,662	,130
	3	,063	,234	,790	-,405	,530
	4	-1,227*	,175	,000	-1,577	-,877
	5	-,658*	,242	,008	-1,140	-,175
	6	-,203	,202	,320	-,608	,201
	7	-,508*	,250	,046	-1,007	-,010
	8	-,920*	,228	,000	-1,374	-,465
	10	-,994*	,192	,000	-1,378	-,610
10	1	1,256*	,213	,000	,831	1,682
	2	,728*	,191	,000	,346	1,110
	3	1,057*	,201	,000	,655	1,459
	4	-,233	,127	,071	-,486	,020
	5	,336	,209	,112	-,081	,754
	6	,791*	,182	,000	,427	1,154
	7	,486*	,203	,020	,080	,892
	8	,074	,219	,735	-,363	,512
	9	,994*	,192	,000	,610	1,378

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

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