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# Testing the Effectiveness of a Mixed-Method Pilot Intervention in Reducing Risky Driving Due to Aggression and Stress

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**Abstract:** The study aimed at testing the effectiveness of a mixed-method pilot intervention in reducing risky self-reported driving performance, upon addressing stress and aggression while driving. The study recruited individuals who had performed these behaviors during the year preceding the study and allocated them into an intervention ( $n = 10$ ) and a control group ( $n = 30$ ). A pre-and postintervention evaluation design was employed to explore changes in risky self-reported driving behaviors, 12 months after the intervention. The intervention involved 2 h of experiential instruction and 1 h of cognitive restructuring using a driving simulator and scenarios appropriate for the processing of driving stress, aggression, and risk. The intervention group displayed significant improvements in the scales of “Hazard Monitoring” ( $p = 0.037$ ) and “Covered Violations” ( $p = 0.049$ ) at the postintervention level. No statistically significant differences were identified in terms of self-reported driving performance between the intervention and the control group at postintervention level. Launching large-scale experimental surveys with broadened cognitive restructuring approaches seems important to deepen our understanding of the behavioral change processes and increase the effectiveness of future interventions.

**Keywords:** stress; aggression; risky driving; intervention; simulation; cognitive restructuring; road safety

## 1. Introduction

Cognitions have been suggested to elicit driving anger and increase crash risk. In fact, biased and erroneous information processing have been thought to be cognitive processes associated with an endogenous propensity to experience excessive anger under provocation. Certain patterns of thinking (e.g., misattributing causation, overgeneralization) have been suggested to be dormant, until activated in stress situations, resulting in excessive anger. Such thoughts have been correlated with driver aggression, in the event of driving-related stressors and with road traffic incidents [1]. For example, it is very common for drivers to perceive other drivers’ behaviors as insults, ending up with a need for retaliation and consequently with aggressive driving and crash involvement. Such correlations between angry thoughts (cognition), driving anger (emotional component), and aggressive behavior (behavioral component) have been consistently recorded in international literature [1–6]. Unfair aggression in the form of violating other drivers’ rights and hostile behavior towards other drivers have been suggested to be dangerous consequences of driving in stressful situations, having also the potential to disrupt smooth circulation due to activating negative emotion and anger [7–10]. Moreover,

prolonged or repeated experience of stressful conditions has been shown to increase aggression [11–13]. Several recently published studies have demonstrated the linear association between driver aggression and the probability of crash involvement [14,15].

Despite the scientific evidence highlighting the impact of driver stress and aggression on risky behavior, a recent systematic review of the literature underlined the fact that empirical evidence has only recently started to develop in terms of cognitive and behavioral interventions used for the improvement of driver aggression [16]. It seems from the review that such interventions are still missing from road safety research despite the wealth of evidence in support of these interventions from other fields of research. Novel interventions using virtual reality and simulation-induced cognitive restructuring in anxiety and anger management have only recently emerged and been tested in pilot studies [17]. Emphasis is thus placed on the need to develop targeted interventions with cognitive restructuring approaches tailored to the special characteristics of various population groups [16,17].

In response to this call for interventions, attention has lately been paid to interventions that use cognitive restructuring to address a wide range of nonclinical issues directly related to driving, such as speeding, unrealistic optimism, risk perception, and limitations of cognition [18–20]. Most of these studies have yielded a significant difference in safety attitudes of drivers between experimental and control groups upon completion of the intervention. Nevertheless, these studies suffered several limitations, including the lack of a control group, the lack of female participants, and a general methodological inconsistency [20].

In Greece, interventions to manage stress and aggression while driving are totally missing. There are various one-day private awareness raising initiatives focusing primarily on the risk behaviors of adults and minors, but none of these have been evaluated in terms of their effectiveness in achieving behavioral change [21]. The current study is preliminary research, conducted in a road safety lab, which is operated by social and behavioral scientists. It aimed to design and test the effectiveness of a mixed-methods pilot intervention in reducing risky driving behavior, upon addressing driving stress and aggression. The study was expected to detect improvements in attitudes and self-reported driving behaviors among those receiving the intervention, 12 months after the intervention. This is a first attempt to apply cognitive behavioral interventions to address driver aggression and the first time assessing and recording indicators of effectiveness of such interventions in the Greek context.

## 2. Materials and Methods

### 2.1. Study Design

A two-stage process was employed for the participants' recruitment. Firstly, individuals were selected from public areas of the region of Crete in Greece, via convenience sampling, based on the following set of inclusion criteria: (a) age (adult men and women), (b) licensure (possessing a driver's license), and (c) driving exposure (driving at least 3 times a week throughout the previous year). Secondly, individuals who met the criteria ( $n = 150$ ), completed the Driver Behavior Questionnaire (DBQ), which served as a filter to identify individuals to be included in the intervention. Individuals displaying the highest scores of risky self-reported driving behavior, based on the DBQ ( $n = 40$ ), were recruited for the intervention study and were randomly allocated to an intervention ( $n = 10$ ) and a control group ( $n = 30$ ) with a ratio of 1:3. In fact, although the optimum case-to-control ratio is thought to be 1:1, it has been suggested that recruiting multiple controls for each case can increase the statistical power when the number of cases is limited [22], as in our study. In terms of evaluation, a pre- and postintervention evaluation design was employed to explore changes in risky self-reported driving behaviors 12 months after the intervention.

### 2.2. Contents of the Intervention

A mixed-method intervention study was designed on the basis of international literature [23–25], combining interview- and simulation-based cognitive restructuring components. Individuals in the

intervention group received a 3-hour individual intervention, which included 2 h of experiential instruction and 1 h of cognitive restructuring using a driving simulator. Certain scenarios were employed to be appropriate for the processing of driving stress, aggression, and risk. The first part of the intervention was about decision-making while driving. The second part addressed common myths on aggressive and risky driving and offered participants the opportunity to reflect on false beliefs about factors that contribute to crash risk. The third part of the intervention concerned the effect of stress on self-reported driving behavior and examined common cognitive errors and violations related to driving. External factors that trigger stress reactions were examined, as well as their impact on self-reported driving behavior. The fourth part of the intervention included time for practicing on the driving simulator and was aimed at increasing participants' understanding of the cognitive errors made while driving. Participants were requested to drive under predetermined conditions, such as driving at high speeds, under the influence of alcohol, and while using a mobile phone. The exercises aimed at improving self-detection and assessment of stress levels experienced at different situations and their association with the crash risk. Participants were interviewed upon completion of the exercises. The interview aimed at exploring the stress levels experienced by the participants as well as their perception of risk, the decisions made while driving, and the actual crash risk.

### 2.3. Research Instruments—Outcome Measures

All the study participants (intervention and control group) completed the following two questionnaires, at pre- and 12 months postintervention:

- (a) Driver Stress Inventory [DSI] [26]: included four scales (“Aggression”, “Thrill Seeking”, “Dislike of Driving”, and “Hazard Monitoring”) with the responses ranging from 0 to 10.
- (b) Driver Behavior Questionnaire DBQ [27]: included two scales (“Unintentional Violations” and “Lapses”), with the responses ranging from 0 to 5.

Individuals allocated to the intervention group completed two additional scales concerning their self-reported performance, at pre- and 12 months post-intervention:

- (a) Driver Attitude Questionnaire (DAQ) [28]: included four scales (“Drinking and Driving”, “Close Following”, “Risky Overtaking”, and “Speeding”) with the responses ranging from 1 to 5.
- (b) Deffenbacher Driving Anger Scale [DAS] [29]: responses ranged from 1 to 5.

### 2.4. Data Analysis

All analyses were performed to describe the participants' key characteristics. Fisher's exact test (for categorical variables) and independent samples *t*-test (for continuous variables) were used to compare the intervention with the control group in terms of their main sociodemographic and driving background characteristics. The nonparametric Wilcoxon matched-pairs signed-ranks test was used to compare the pre- and the postintervention performance of those who received the intervention in terms of anxiety, driver aggression, and risky self-reported driving behavior. The nonparametric Kruskal–Wallis test was used to explore the differences between the intervention and the control group in terms of anxiety, driver aggression, and risky self-reported driving scores, at postintervention level. All analyses were performed with SPSS v. 21.0 and STATA v. 12.0 and a significance level of 0.05 was used as a threshold to determine the statistically significant differences.

## 3. Results

### 3.1. Participants' Profile

The sociodemographic and the driving profile of the two groups are presented in Table 1. The intervention group involved 10 participants (8 men), with a mean age of 26.2 (SD 7.5) years. Six of them (60.0%) reported a driving experience of  $\leq 5$  years, 7 (70.0%) used a car on daily basis,

and 5 (50.0%) had been involved in a car accident during the past year. On the other hand, the control group involved 30 participants with 19 male (63.3%) and a mean age of 27.8 (SD 9.9) years. More than half of them ( $n = 77$ ; 56.7%) reported a driving experience of  $\leq 5$  years and the majority (68.7%) used a car on daily basis. The car was the most common means of transport for the majority of the participants (72.0%). Nearly half of them ( $n = 13$ ; 43.3%) had been involved in a traffic accident in the past year. Comparisons at the preintervention level between the two groups in terms of their sociodemographic and driving profiles showed no statistically significant differences ( $p > 0.05$ , Table 1). This indicates that the two groups were relatively equivalent in terms of key personal characteristics.

**Table 1.** Participant sociodemographic and driving characteristics.

Personal Characteristics	Control Group	Intervention Group	<i>p</i> -Value *
	Mean (SD) n (%)	Mean (SD) n (%)	
<b>Age (years)</b>	27.8 (9.9)	26.2 (7.5)	0.651
<b>Gender</b>			0.451
Male	19 (63.3)	8 (80.0)	
Female	11 (36.7)	2 (20.0)	
<b>Driving Years</b>			0.230
<1 year	1 (3.3)	1 (10.0)	
1–5 years	17 (56.7)	5 (50.0)	
6–10 years	6 (20.0)	0 (0.0)	
$\geq 11$ years	6 (20.0)	4 (40.0)	
<b>Driving Frequency</b>			0.298
Every day	21 (70.0)	7 (70.0)	
Sometimes weekly	3 (10.0)	3 (30.0)	
Sometimes monthly	2 (6.7)	0 (0.0)	
Less often	4 (13.3)	0 (0.0)	
Not at all	0 (0.0)	0 (0.0)	
<b>Most common means of transport</b>			0.186
Bus	6 (20.0)	0 (0.0)	
Truck	0 (0.0)	1 (10.0)	
Car	21 (70.0)	8 (80.0)	
Motorcycle	3 (10.0)	1 (10.0)	
Bicycle	0 (0.0)	0 (0.0)	
<b>Car accident in the last year</b>			0.731
Yes	13 (43.3)	5 (50.0)	
No	17 (56.7)	5 (50.0)	

\* Significance level 0.05.

### 3.2. Self-Reported Driving Behavior of the Intervention Group at Pre-and Postintervention Level

Comparison between the pre- and the postintervention self-reported driving behavior of the intervention group is presented in Table 2. A statistically significant difference was evident in the “Hazard Monitoring Scale” (DSI), with the median value being 0.8 at 12 months postintervention (median 25th–75th; 6.6 (5.6, 7.0) as compared with 5.8 (5.4, 6.9) at preintervention level ( $p = 0.037$ )). This difference implies that 12 months after the intervention, the participants of the intervention group displayed significant improvements in their self-reported driving performance in terms of danger detection while driving. Furthermore, there has been a statistically significant difference in the “Covered Violations Scale” (DBQ), with the median value being lower by 0.7 at postintervention (median (25th–75th): 0.8 (0.7, 1.3) as compared with 1.5 (1.3, 2.2) at preintervention level ( $p = 0.049$ )). This difference implies that 12 months after the intervention, participants of the intervention group displayed significant improvements in their self-reported violations. No statistically significant differences were found in any of the other scales ( $p > 0.05$ , Table 2) although the scores at the postintervention level were slightly improved as compared with the ones at preintervention.

**Table 2.** Self-reported driving performance (intervention group).

Scale	Preintervention	Postintervention	<i>p</i> -Value
	Median (25th–75th)	Median (25th–75th)	
Aggression	5.0 (4.7, 5.3)	4.8 (4.3, 5.5)	0.594
Dislike of Driving	4.9 (3.6, 5.3)	4.8 (4.1, 5.3)	0.362
Thrill Seeking	4.7 (0.3, 5.4)	2.9 (1.8, 4.9)	0.767
Hazard Monitoring	5.8 (5.4, 6.9)	6.6 (5.6, 7.0)	0.037
Covered Violations	1.5 (1.3, 2.2)	0.8 (0.7, 1.3)	0.049
Unintentional Violations	1.0 (0.5, 1.0)	0.5 (0.0, 1.0)	0.217
Lapses	1.1 (0.7, 1.6)	0.9 (0.6, 1.1)	0.260
Drinking and driving	3.2 (2.6, 3.4)	3.0 (2.8, 3.6)	0.812
Close Following	3.2 (3.0, 3.2)	3.2 (3.0, 3.4)	0.631
Risky Overtaking	3.8 (3.4, 3.8)	3.6 (3.4, 4.0)	0.377
Speeding	3.8 (3.8, 4.0)	4.2 (3.2, 4.6)	0.678
Driving Anger Scale	3.2 (3.0, 3.2)	2.6 (2.2, 3.2)	0.214

### 3.3. Self-Reported Driving Behavior of the Control Group at Pre-and Postintervention Level

The self-reported driving behavior of the control group is presented in Table 3. Comparisons between the pre- and the postintervention performance of the control group in the DSI and the DBQ scales showed no statistically significant difference ( $p > 0.05$ , Table 3).

**Table 3.** Self-reported driving performance (control group).

Scale	Preintervention	Postintervention	<i>p</i> -Value
	Median (25th–75th)	Median (25th–75th)	
Aggression	5.3 (4.4, 5.8)	5.2 (4.3, 5.7)	0.599
Dislike of driving	3.9 (3.2, 5.1)	3.9 (3.3, 4.5)	0.681
Thrill Seeking	3.3 (2.0, 4.1)	3.4 (2.5, 4.3)	0.992
Hazard Monitoring	6.0 (5.1, 6.4)	5.6 (5.3, 6.3)	0.319
Covered Violations	1.0 (0.9, 1.2)	1.0 (0.7, 1.2)	0.127
Unintentional Violations	0.5 (0.5, 1.0)	0.5 (0.5, 1.0)	0.719
Lapses	0.7 (0.6, 1.1)	0.9 (0.7, 1.1)	0.181

### 3.4. Comparison between the Intervention and the Control Group in Terms of Their Self-Reported Driving Behavior after the Intervention

Despite the fact that the self-reported driving behavior of the intervention group was slightly better than the one of the control group in certain domains (e.g., “Aggression”, “Thrill Seeking”, “Hazard Monitoring”, “Unintentional Violations”), those differences were not shown to be statistically significant in any of the scales examined at 12 months postintervention ( $p > 0.05$ , Table 4).

**Table 4.** Self-reported driving behavior after the intervention (intervention vs. control group).

Driving Behavior	Group		<i>p</i> -Value
	Control	Intervention	
	Median (25th–75th)	Median (25th–75th)	
Aggression	5.2 (4.3, 5.7)	4.8 (4.3, 5.5)	0.802
Dislike of Driving	3.9 (3.3, 4.5)	4.8 (4.1, 5.3)	0.072
Thrill Seeking	3.4 (2.5, 4.3)	2.9 (1.8, 4.9)	0.764
Hazard Monitoring	5.6 (5.3, 6.3)	6.6 (5.6, 7.0)	0.095
Unintentional Violations	1.0 (0.7, 1.2)	0.8 (0.7, 1.3)	0.615
Covered Violations	0.5 (0.5, 1.0)	0.5 (0.0, 1.0)	0.407
Lapses	0.9 (0.7, 1.1)	0.9 (0.6, 1.1)	0.960
Drinking and Driving	3.0 (2.6, 3.4)	3.0 (2.8, 3.6)	0.637
Close Following	3.2 (2.8, 3.6)	3.2 (3.0, 3.4)	1.000
Risky Overtaking	3.4 (3.0, 3.6)	3.6 (3.4, 4.0)	0.089
Speeding	3.6 (3.2, 3.8)	4.2 (3.2, 4.6)	0.161
Driving Anger Scale	2.8 (2.4, 3.5)	2.6 (2.2, 3.2)	0.317

#### 4. Discussion

The mixed-model pilot intervention designed for this study has not been able to confirm all the original assumptions. No solid evidence was derived regarding the effectiveness of short-term cognitive restructuring and simulation stimuli in reducing self-reported stress and aggression while driving. Nevertheless, improvements achieved in certain domains of self-reported driving performance (Hazard Monitoring  $p = 0.037$ ; Covered Violations  $p = 0.049$ ) need to be acknowledged as they are considered to be initial evidence of effectiveness with great potential in influencing other domains of safe driving. In fact, Rowden et al. [10] noted that hazard detection encourages the driver to adopt a more responsible behavior in driving, thereby reducing offenses, and given the short term intervention applied, it is a positive outcome for the intervention group, which could mean that long-term intervention could be possible to make a significant difference. Our findings, even though not as strong as reported in Zinzow et al. [17], who found a 29% decline in aggressive driving and a 21% decline in risky driving, suggest that such interventions, if appropriately redesigned, can prove to be useful in terms of reducing risky self-reported driving behavior and stress levels while driving.

What also stands out from the results is the fact that improvements achieved in this study in the intervention group were still evidenced a year after the intervention. This could imply that our intervention holds the potential of bringing and maintaining changes in certain driving domains, in the long run. However, we need to acknowledge that the design of this study does not allow drawing such conclusions securely, as the investigation of other confounding factors, which may have influenced our participants' self-reported behaviors, was not possible.

Interestingly, among the DAQ attitudes that were targeted through the intervention, attitudes towards "Speeding" became even more lenient after the intervention, while attitudes towards other domains either slightly improved (e.g., "Drinking and Driving" and "Risky Overtaking"), or remained unaffected a year after the intervention ("Close Following"). This finding is consistent with previous research identifying speeding as a common aberrant driving behavior, which is less influenced by interventions [28,30,31]. Although these observations were not found to be statistically significant, they still have the potential to indicate directions for future research.

Another important observation that needs to be acknowledged is related to the performance of the two groups in most of the domains of safe driving, a year after the intervention. Although the differences between the intervention and the control group in self-reported driving behaviors were not shown to be statistically significant, the fact that self-reported driving performance was improved in the intervention group and worsened in the control group a year after the intervention is a piece of evidence that holds a lot of promise and needs further investigation.

##### *Strengths and Weaknesses*

It is important to acknowledge a number of weaknesses and strengths of the study for future reference. Firstly, convenience sampling leads to results that are not generalizable to the general population. Secondly, the small number of participants in the current intervention cannot lead to safe conclusions. Thirdly, the self-report method that was employed in the current study may include recall errors. Fourthly, a brief intervention may not be sufficient enough to address all the important parameters of safe driving.

Among the strengths of this study, the most important ones are the mixed-method design of the intervention, the delivery of the intervention on an individual basis, the use of standardized instruments, and the long-term follow-up, which seems to be missing from similar interventions. The results could have been different if a longer intervention had been designed and if complementary teaching methods were employed, such as virtual reality technology. A pilot study conducted by Zinzow et al. [32] on U.S. veterans who presented with signs of driving phobia, hyperarousal, anxiety/anger related thoughts and behaviors, risky driving, and PTSD symptoms has shown great effectiveness in managing a decline in hyperarousal in driving situations and aggressive and risky driving with the use of virtual reality and cognitive behavioral intervention in multiple sessions.

## 5. Conclusions

The current pilot intervention has been partly successful in reducing driving violations, a major cause of traffic accidents. If the sample in the intervention group was larger, there would be a greater chance of detecting statistically significant differences in stress and risky driving between the intervention and the control group. Nevertheless, the maintenance of behavioral change in the long term could be considered the major success of this study, which offers us important input for future initiatives. The improvements found in this study should be handled with caution due to the various study limitations.

What comes out of the findings of this study is the fact that combining psychological interventions with practice learning on simulated environments could be effective in achieving and maintaining changes in the long term in certain behavioral elements. Revisiting the study design in future initiatives would be important. Introducing a large-scale intervention design that contains an extended number and duration of sessions, focusing on the individual or the group, with a therapeutic approach and plan, would probably strengthen the outcomes and contribute to the longer maintenance of the behavioral gains. Introducing complementary evaluation methods and more sophisticated analysis would also be important in the future, in order to be able to capture more information regarding the profile of participants who display greater propensity to risk behavior. Finally, future interventions could consider employing anger management interventions, tranquility enhancement, and general self-control strategies to treat aggression as an element of participants' personality in cases of high levels of aggressive driving.

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