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The impact of Stereotype Threat on the simulated driving performance of older drivers

Mélanie Joanisse[a], Sylvain Gagnon[a,b,*], Mihnea Voloaca[a]

[a] School of Psychology, University of Ottawa, Cognitive Aging and Driving Laboratory, United States
[b] Elizabeth Bruyère Research Institute, United States

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ABSTRACT

Older drivers are perceived as being dangerous and overly cautious by other drivers. We tested the hypothesis that this negative stereotype has a direct influence on the performance of older drivers. Based on the Stereotype Threat literature, we predicted that older driving performance would be altered after exposure to a Stereotype Threat. Sixty-one older drivers aged 65 and above completed a simulated driving assessment course. Prior to testing, half of the participants were told that the objective of the study was to investigate why older adults aged 65 and above were more implicated in on-road accidents (Stereotype Threat condition) and half were showed a neutral statement. Results confirmed that exposure to the threat significantly altered driving performance. Older adults in the Stereotype Threat condition made more driving mistakes than those in the control group. Interestingly, under a Stereotype Threat condition, older adults tended to commit more speeding infractions. We also observed that domain identification (whether driving is deemed important or not) moderated the impact of the threat. Taken together, these results support recent older drivers' performance models suggesting that the interaction between individual and social factors need to be considered when examining older drivers' performance.

1. Introduction

By 2030, it is expected that the population of drivers aged 65 and above will reach approximately 57 million in the United States alone (United States Government Accountability Office, 2007). Understandably, these projections have generated widespread interest in the issue of the fitness to drive of older drivers, both in the scientific community and in the media. Unfortunately, this intensified interest in older drivers is not only motivated by objective scientific scrutiny. Indeed there is evidence suggesting that the general population holds a predominant negative view of the older driver. In the grey literature, Martin et al. (2005) observed from newspapers articles reporting on on-road accidents involving older adults that 58% were demeaning of older drivers (e.g., *Old dear trashes 7 cars*), 15% were positive, and 27% were neutral. Furthermore, studies have shown the age of the driver can influence perception of on-road aggression and on-road reactions, attribution of responsibility for accidents and likelihood of police investigation (Carver and de la Garza, 1984; Davies and Patel, 2005; Matthews and Moran, 1986; Rosenfeld et al., 2011).

We recently validated the existence of older driver stereotypes (Joanisse et al., 2012) using simulated clips of on-road behaviors. Participants were asked to review three categories of simulated driving behaviors (i.e., younger adults' unsafe behaviors, older drivers' unsafe behaviors, and appropriate and optimal driving reactions) and rate how representative these driving behaviors were of a typical younger, middle-aged, or older driver. Findings revealed that while some safe on-road reactions were associated with older drivers, participants held primarily a negative perception of older drivers. Specifically, participants indicated that unsafe behaviors rarely seen in older drivers were representative of the typical older driver. A qualitative analysis performed in a following experiment revealed that the typical older driver was described as overly cautious, uncomfortable behind the wheel, and unsafe and dangerous (Joanisse et al., 2012). Observations supporting the concept of the older driver stereotype were also described in other investigations (Carver and de la Garza, 1984; Davies and Patel, 2005; Glendon et al., 1996; Matthews and Moran, 1986; Parker et al., 2001).

This negative view of the older driver is alarming given that recent theoretical driving models have highlighted the likely influence of self-monitoring, beliefs about driving abilities, and environmental factors on driving performance (Anstey et al., 2005;

* Corresponding author at: School of Psychology, University of Ottawa, Cognitive Aging and Driving Laboratory, 136 Jean Jacques Lussier, Vanier Hall (3042), Ottawa, ON K1N 6N5, United States. Tel.: +1 613 562 5800x2515; fax: +1 613 562 5147.
E-mail addresses: mjoan022@uottawa.ca (M. Joanisse), sgagnon@uottawa.ca (S. Gagnon), mvolo025@uottawa.ca (M. Voloaca).

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Lindstrom-Forneri et al., 2010). In their transactional model of driving in older individuals, Lindstrom-Forneri et al. (2010) expressed the need for research to examine global and environmental factors such as social policies, laws, and institutional factors. They also explicitly stated that negative stereotypes of aging drivers could influence driving competence of the older adults. However, the link between negative stereotypes and older adults' driving has yet to be supported by empirical evidence.

We believe that the Stereotype Threat paradigm is particularly suitable for this endeavor. The Stereotype Threat paradigm posits that in an evaluative context, individuals tend to confirm the negative stereotypes about their group's performance on a particular task when they are reminded of these stereotypes (Aronson et al., 1998; Steele, 1997; Steele and Aronson, 1995). The influence of Stereotype Threat on performance has been found in various contexts with different populations across numerous domains, including the performance of: African-American college students on intelligence tests (Steele and Aronson, 1995); women on math assessment tests (Cadinu et al., 2005; Good et al., 2008; O'Brien and Crandall, 2003; Schmader, 2002; Schmader and Johns, 2003), low-income individuals on tests of verbal abilities (Croizet and Claire, 1998); traumatic brain injury survivors on neuropsychological test results (Suhr and Gunstad, 2002; see also Wheeler and Petty, 2001 for a review), young university women on negotiating skills (Kray et al., 2004, 2001), and gay men's social interaction with pre-school children (Bosson et al., 2004).

Older adults have also been found to be sensitive to stereotype-based threats. Research has shown that when confronted with information or instructions indicating that memory declines with old age (negative stereotype), or that a given task offers a memory diagnostic, memory performance was significantly decreased, especially for those who valued this ability (Chasteen et al., 2005; Hess et al., 2003). While most of the studies on Stereotype Threat and aging have examined the detrimental effects of stereotypic expectations on various cognitive domains, one recent study has looked at the effects of Stereotype Threat on older adults in the driving domain (Gaillard et al., 2011). Using the Regulatory Focus Theory (Higgins, 1997), this study examined the self-regulating processes that could moderate the influence of positive and negative expectancies on the performance of older adults on a written driving test. Their findings revealed that the test scores of prevention-focused older adults (i.e., apprehensive of negative consequences, loss and more likely to display safe, and defensive strategies to attain minimal goals) were negatively altered when exposed to negative expectations and improved when exposed to positive expectations (Gaillard et al., 2011). Conversely, promotion-focused participants (i.e., oriented towards advancement, growth, gains, and more likely to display eager and ambitious strategies to achieve goals) test scores were not significantly influenced by negative or positive expectations. Considering that Stereotype Threat can influence the older adults' performance on a written examination of driving knowledge, it seems logical to investigate whether its negative influence can also be observed while driving. This approach seems particularly suitable given that Yeung and von Hippel (2008) have shown that women assessed under Stereotype Threat were more likely to hit a pedestrian who unexpectedly crossed the road in a simulated driving task, in comparison to women exposed to neutral information.

Furthermore, Stereotype Threat is more likely to influence one's reactions when the domain assessed is meaningful to the individual (Aronson et al., 1998; Hess et al., 2004; Lesko and Corpus, 2006; Spencer et al., 1999). Given that for a large proportion of older drivers, driving symbolizes freedom, autonomy, as well as independence (Classen et al., 2009; Rudman et al., 2006; Yassuda and Wilson, 1997), and is seen as their favored mode of transportation (Martinez, 1995), it seems justified to postulate that their driving performance could be altered in a Stereotype Threat context.

Therefore, drawing from the above empirical data and theoretical models of aging and driving, we hypothesized that older drivers exposed to a Stereotype Threat condition will perform more poorly on a driving assessment completed on a driving simulator. More explicitly, it is expected that when told that the objective of the study is to understand why older drivers are more implicated in on-road accidents (Stereotype Threat condition), older drivers would exhibit more driving errors and would be more likely to crash in reaction to a surprising simulated on-road event, compared to participants in the control condition. We also examined whether domain identification could moderate the influence of Stereotype Threat on driving performance. We hypothesized that individuals who valued driving would respond more strongly to the Stereotype Threat condition than those who highly value driving in the control group.

2. Methods

2.1. Participants

Ninety-nine participants (38 women and 61 men) aged between 64 and 88 (M = 71.41, SD = 5.50) from Canada's Capital Region (Ottawa) took part in this study. All participants were required to hold a valid driver's license. Participants needed to be generally healthy and without specific health-related problems that could interfere with their driving abilities (i.e., neurological and psychomotor diseases, substance abuse, and history of severe head trauma). Recruitment strategies included putting advertisements in local papers, as well as placing flyers in community centers, libraries, recreational centers, and street posts. Alumni and retiree associations, veterans groups, and seniors' clubs were also solicited for their help via telephone, mail, and email. Socio-demographic data revealed that 65% reported English as their mother tongue, 15% French, and 20% other. Most participants indicated White/European as their ethnicity. Their driving experience ranged from 5 to 67 years (M = 51.83, SD = 9.01), and they reported driving an average of 980 km per month (SD = 820).

Health history was surveyed through a health questionnaire administered over the phone. Most participants (i.e., 95%) reported being in good health or better (i.e., very good, and excellent). Severe cognitive decline was screened using the Mini Mental State Examination (MMSE; Folstein et al., 1975). Only one participant scored below the 24 cutoff score (Spreen and Strauss, 1998) and was removed from the sample. In total 38 participants were removed for reasons that will be explained in Section 4. Participants took part in the study on a voluntary basis. Parking fees or bus fares were reimbursed. Participants received $10 as compensation. All participants gave formal consent prior to testing in compliance with the University of Ottawa Research Ethics Board requirements.

2.2. Material

2.2.1. Induction of the Stereotype Threat

Prior to the simulated driving task, participants were asked to read the objective of the study displayed on the central simulator screen. Half of the participants were told that the objective of the study was to investigate why older adults aged 65 and above were more implicated in on-road accidents (Stereotype Threat condition) while the other half were told that the objective was to understand the underlying processes involved in driving (control condition).

2.2.2. Simulated driving task

The driving simulator used was a high-fidelity STISIM (Build 2.08.04) developed by Systems Technology Inc. The simulator comprises a driver's seat, a steering wheel, and pedals. Three white panels (75 cm × 90 cm) are situated approximately 144 cm from the driver, which produces a field of view of 135°. Three NEC VT440 projectors are situated behind the driver' seat and project the simulated driving course on the three screens (at 30 frames/s). The simulator is powered by four Dell Dimension 9200 computers using the Windows XP SP2 operating system (running on 2.4 GHz Intel Core2 Duo processors).

The simulated task used in this study mimicked a G2 examination, a road test used in the Canadian province of Ontario to assess the driving skills necessary to obtain a driver's license. The simulated circuit was developed by a group of researchers at Lakehead University (see Weaver et al., 2009). The circuit was approximately 12.2 km long and was completed in 18 min on average. While most of the roads displayed were four-lane urban roads, participants also had to drive on two-lane residential roads. The driving environment contained common road signs (i.e., stop signs, intersection signs), traffic in the form of cars and trucks (i.e., incoming and same-way traffic), cyclists, and pedestrians. In total, participants had to make nine right turns, seven left turns, five lane changes, and had to drive through an intersection on three occasions. Participants received pre-recorded auditory instructions through speakers located behind the projection panels (e.g., turn right/left, change lanes).

Inspired by the methodology of Yeung and von Hippel (2008), we modified the original simulated circuit to include a surprising event. We chose the *Car Overtaking* driving scenario developed by Bélanger et al. (2010), given the level of difficulty of this scenario seemed to limit the occurrence of ceiling or floor effects in their sample of older drivers. In this scenario, the driver sees a bus coming from the opposite lane, but is unable to perceive the occluded car behind it. At a programmed time, the occluded car suddenly engages in overtaking the bus by going into the driver's lane, hence obstructing the driver's path. The driver has approximately 3 s to react by braking and swerving to the right.

Scoring. Once the participant has completed the assessment course, the simulator generates a global performance score based on the number of mistakes made, which include number of: (1) collisions, (2) pedestrians hits, (3) speeding, (4) traffic light tickets, (5) stop signs missed, (6) illegal turns, (7) centerline crossings, and (8) road edge excursions. Additionally, the simulator computes the total run length and the presence or absence of a collision during the surprising event. The participants' driving parameters are captured every tenth of a second. The performance of all participants was recorded and reviewed to ensure accurate and valid scoring from the simulator. While not being captured by the driving simulator, we also included the number of missed instructions. This type of error was scored while reviewing the recorded assessments. Previous research has found that Stereotype Threat tends to generate performance-related anxious thoughts that decrease the cognitive resources (e.g., attention, and working memory) available to accomplish the task (Beilock et al., 2006, 2007; Croizet et al., 2004; Schmader and Johns, 2003; Stone and McWhinnie, 2008).

2.2.3. Domain identification

Earlier studies have shown that participants are more vulnerable to Stereotype Threat when the performance domain being assessed is personally important (Aronson et al., 1999; Hess et al., 2004; Lesko and Corpus, 2006; Spencer et al., 1999). For this reason, during the phone interview, all participants were asked: How important is driving in your life? Answers could range from 1 = *Not at all important* to 5 = *Extremely important*.

2.2.4. Acknowledgement of the experimental manipulation by the participants

To ensure all participants paid attention to the information displayed on the central screen prior to the simulated task, we adapted the procedure of Andreoletti and Lachman (2004) and asked the following question at the end of testing: What was the objective of this study? Participants had to choose between the following statements: (1) investigate why older drivers aged 65 and greater are more implicated in on-road collisions than younger and middle-aged drivers, (2) investigate why older drivers aged 65 and greater are less implicated in on-road collisions than younger and middle-aged drivers and (3) further our understanding of drivers' on-road reactions (no mention of age-related differences).

2.2.5. Follow-up questionnaire

Participants were also queried on their perception of the task in order to uncover variables that could have mediated or moderated the impact of the Stereotype Threat effect. Similar to Yeung (2006) and Schmader and Johns (2003), we queried participants in regards to the difficulty of the task (*I found the simulated driving task to be difficult*), their awareness of the stereotype associated with their age group (*Even before I registered for this study, I felt that older drivers were perceived as bad drivers by society*), and perceived threat of the experimental context (*The experimenter expected me to do poorly based on my age*). We asked questions pertaining to perceived validity of the task (*I displayed my true driving abilities in the simulated driving task*) as previous research has found that individuals in Stereotype Threat conditions tended to discount or criticize the task used to assess their performance (e.g., Lesko and Corpus, 2006). Perceived pressure from the experimental manipulation was also queried (*During this study I felt under pressure to prove that older drivers are safe drivers*). All answers to the above questions were rated on a 5-point Likert scale, 1 = *Strongly disagree* to 5 = *Strongly agree*.

3. Procedure

Individuals interested in participating in the study contacted the University of Ottawa's Cognitive Aging and Driving Laboratory via email or phone. During a phone interview, participants completed a sociodemographic questionnaire and answered questions related to their driving experience and qualifications (e.g., status of their drivers' license, average number of kilometres driven in a month, number of traffic accidents since obtaining license, importance of driving in their lives) as well as their health status.

Simulator testing took place at the University of Ottawa's Cognitive Aging and Driving Laboratory and lasted approximately 90 min. The real objective of the study was concealed to minimize response bias. After signing a consent form, participants were asked to complete the MMSE (Folstein et al., 1975). Prior to the simulated task, the experimenter described and explained the driving simulator components (e.g., gas and brake pedal, signals, blinkers, and mirrors). Participants then completed a 15-min orientation session to familiarize themselves with the driving simulator. Participants had to complete a short circuit requiring them to (1) comply with the displayed speed limits, (2) complete turns on double-lane roads, (3) follow road signs and traffic lights, and (4) complete turns at intersections (see Cyr et al., 2009). Participants' well-being before and after the orientation session was monitored using the Simulator Sickness Questionnaire (SSQ; Kennedy et al., 1993). This questionnaire examines 16 symptoms of simulator sickness on a 4-point scale ranging from 0 = *Not at all* to 4 = *Severe*. Once the orientation session was completed, participants were randomly assigned to either the experimental or the control condition. Up until this point, the experimenter was blind to the assigned testing condition.

Participants were then asked to read the objective of the study displayed in the central screen and when ready to initiate the simulation. Following the completion of the simulated driving task, participants were asked to complete the SSQ (Kennedy et al., 1993) once more. Participants then completed the experimental manipulation questionnaire as well as the follow-up questionnaire. Subsequently, the experimenter debriefed all participants on the actual objective of the study. The rationale for the use of deception was explained and participants were given the choice to withdraw from the study without any consequences. Participants who wished to remain in the study despite deception signed a second consent form specifying the real objective of the experiment. All participants agreed to remain in the study after debriefing.

4. Results

4.1. Sample attrition

Five participants were removed from the sample given that their answers on the medical questionnaire revealed that they had health problems that could interfere with their performance (e.g., important vision problems, on-going psychiatric disorders, and elevated alcohol consumption). Twenty-six participants also had to be dropped from the sample because they were unable to complete the simulated task due to symptoms associated with simulator sickness. Given the initial sample size, this number is proportionate to those observed in previous driving simulation studies (see Mullen et al., 2010). In addition, a research assistant reviewed the performance of all participants during the orientation session and identified 14 participants who seemed to have difficulty mastering handling the simulator throughout the orientation session. Three other researchers who were blind to the experimental condition of these participants reviewed the driving performance of these individuals. To be conservative, participants were excluded only if perfect inter-rater agreement was reached that they had significant difficulty adjusting to the simulator (i.e., driving on sidewalks, inappropriate braking, frequent crashes, loss of control, and inability to maintain an appropriate speed) in the last 8 km of the 15 km orientation course. Four participants were removed from the sample for these reasons. Lastly, three participants were unable to accurately answer which objective they had read before the simulation and as a consequence were excluded from the statistical analysis. Statistical analyses were therefore performed on the remaining 61 individuals (41 men and 20 women) aged between 65 and 88 years old ($M = 71.57$ and SD = 5.47); 29 older adults were in the control condition (13 men and 16 women; $M_{age} = 70.59$ and SD = 4.63), and 32 in the experimental condition (25 men and 7 women; $M_{age} = 72.47$ and SD = 6.06). Independent-samples t-tests revealed that the retained and excluded participants did not significantly differ in age, $t(97) = -.364$, $p = .717$, level of education $t(97) = -.634$, $p = .527$, reported health $t(97) = -1.695$, $p = .093$, MMSE scores $t(97) = -.976$, $p = .331$, driving experience $t(97) = -.697$, $p = .487$, kilometres driven on average per month $t(45.96) = 1.85$, $p = .071$, number of accidents since obtaining license $t(97) = -.181$, $p = .857$, and importance of driving in their lives $t(97) = .373$, $p = .710$.

4.2. Preliminary analysis

Independent-samples t-tests analyses performed on the aforementioned variables yielded only one significant difference between the experimental group and the control group. Individuals assigned to the control group were found to be more educated compared to their counterparts in the experimental group, $t(59) = 2.19$, $p = .033$. There were no significant differences for age, $t(57.42) = -1.37$, $p = .176$, reported health $t(59) = .378$, $p = .707$, MMSE scores $t(59) = -1.02$, $p = .311$, driving experience $t(59) = -1.44$, $p = .155$, kilometres driven on average per month $t(59) = -.608$, $p = .545$, number of accidents since obtaining license $t(59) = .523$, $p = .603$, and importance of driving in their lives $t(59) = -1.17$, $p = .246$. In an analysis described below, we examined whether the education variable moderated the Stereotype Threat effect.

Table 1
Number of collisions made by participants according to the testing condition.

	Control condition	Stereotype threat condition
Total collisions	18	18
Collisions during surprising event	13	16

4.3. Number of driving mistakes

To test our main hypothesis that individuals under Stereotype Threat condition would make more driving mistakes on average than individuals not submitted to such threat, we conducted an independent-samples t-test on the average of mistakes made by the participants tested in both conditions. Specifically, we combined the mistakes computed by the simulator to make a composite score. The analyses revealed that the results supported our hypothesis $t(59) = -2.10$, $p = .04$. Older adults in the Stereotype Threat condition ($M = 12.00$, SD = 6.37) made more mistakes than participants from the control group ($M = 9.00$, SD = 4.50).

The next analysis examined whether the difference observed on the total number of errors was attributed to a specific error subtype. Independent t-tests were conducted on each type of driving mistakes separately and revealed that there was no significant differences between the conditions, $t(59) = -1.75$, $p = .09$ for speeding, $t(59) = -0.829$, $p = .41$, for traffic lights tickets, $t(59) = -0.925$, $p = .36$, for stop signs missed, $t(59) = 0.451$, $p = .65$ for centerline crossings, $t(59) = -1.26$, $p = .21$, for road edge excursions, and $t(59) = -1.17$, $p = .25$ for missed simulator instructions. Given that none of the participants hit a pedestrian, the pedestrian hit sub-score was not analyzed. Pearson correlations (Bonferroni corrected) were also computed to determine how the different types of driving mistakes correlated with the overall score. A total of 2 mistakes correlated significantly with the total mistakes made by participants, namely, speeding ($r = .927$, $p < .01$), and missed simulator instructions ($r = .351$, $p < .01$). Driving mistakes by error subtypes according to the testing condition are shown in Fig. 1.

The number of overall collisions in reaction to the surprising event *Car Overtaking* was specifically examined to validate our hypothesis that older drivers under the effect of the Stereotype Threat would be more likely to crash. Contrary to our hypothesis, chi-square of independence results revealed that there was no significant association between the testing condition and the presence or absence of a crash, $\chi^2(1, N = 61) = 0.163$, $p = .67$. Older adults in the Stereotype Threat condition were not more likely to crash during the surprising event than were participants in the control group. Indeed, nearly half of participants in each condition collided with the occluded car (45% in the control condition and 50% in the stereotype treat condition, see Table 1). In other segments of the scenario, crashes rarely occurred in both the control (5 crashes) and the experimental (2 crashes) groups.

4.4. Potential moderators of stereotype threat on driving mistakes

There is evidence that education moderates the impact of Stereotype Threat (Andreoletti and Lachman, 2004; Hess et al., 2009). Consequently, we conducted a separate analysis using the

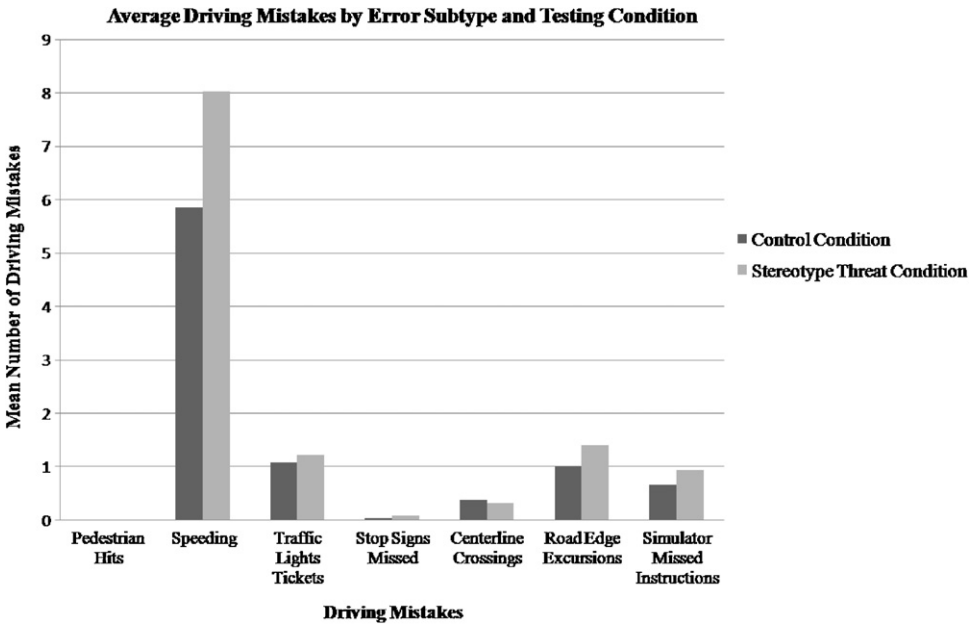

Fig. 1. Average driving mistakes by error subtypes and testing condition.

testing condition and education as independent variables. The education variable that originally comprised 11 levels was brought down to two levels: those with less than a University degree, and those with University studies. Using such a splitting strategy, 8 control participants and 17 experimental participants fell into the less than a University degree category and 21 control and 15 experimental participants fell into the University studies category). A two-way ANOVA, Conditions (Stereotype Threat and control) × Education (less than a University degree and some University studies) was conducted on overall driving mistakes. The analysis showed no significant interaction $F(1,57) = 0.014$, $p = .906$ ($\eta_p^2 = 0.00$, observed power = 0.052) or main effect of education, $F(1,57) = 1.88$, $p = .176$ ($\eta_p^2 = 0.32$, observed power = 0.270). Despite not being statistically significant, in both conditions, there was somewhat of a tendency for highly educated older adults to make fewer mistakes ($M = 10.80$ and SD = 1.44 for Stereotype Threat group; $M = 8.48$, SD = 1.21 for control group) than those with less education ($M = 13.06$ and SD = 1.35 for Stereotype Threat group; $M = 10.35$, SD = 1.97 for control group).

We also tested the prediction that domain identification would moderate driving mistakes through the computation of a two-way ANOVA, (Condition) × (Domain Identification), with overall driving mistakes as the dependant variable. Most participants were strongly identified to driving. Indeed, 84% reported that driving was either very important or extremely important to them. Therefore, we separated the participants into two categories: those who said that driving was very important or less from those who said that driving was extremely important. Results revealed a significant interaction $F(1,47) = 6.66$, $p = .013$ ($\eta_p^2 = 0.124$, observed power = 0.715), no main effect of condition $F(1,47) = 2.10$, $p = .154$ ($\eta_p^2 = 0.043$, observed power = 0.295), as well as no main effect of driving identification, $F(1,47) = 2.60$, $p = .113$ ($\eta_p^2 = 0.053$, observed power = 0.353). Post hoc contrasts corrected with Bonferroni revealed that older adults tested in the Stereotype Threat condition for whom driving was rated as extremely important made significantly more driving mistakes ($M = 12.94$, SD = 6.93) than older adults in the control condition who also rated driving as being extremely important ($M = 6.58$, SD = 2.68; $p = .004$), see Table 2. The analysis yielded another significant contrast within the control condition. Participants who reported driving as very important in their lives made more mistakes ($M = 13.20$, SD = 1.75) than those for whom driving was rated as extremely important ($M = 6.58$, SD = 2.68).

We were also interested in finding out whether other variables moderated the Stereotype Threat manipulation. Correlational analyses indicated that there were no significant relationships between age, average number of kilometres driven per month, driving experience, reported health, and the total number of mistakes made by participants (all p's > .05).

4.5. Answers to the follow-up questionnaire

The last set of analyses examined whether the participants' perception of the task influenced their performance. This was achieved by comparing their answers on the 5 post-experiment questions (Perceived Validity of the Task, Difficulty of the Task, Awareness of the Stereotype associated with their Age Group, Perceived Threat of the Experimental Context, and Perceived Pressure) and Condition as the independent variable. The analyses revealed that the two groups differ on only one question $t(55) = -2.54$, $p < .05$. Older adults from the control condition reported the simulated task to be more difficult to accomplish ($M = 3.41$, SD = .797) than older adults in the Stereotype Threat condition ($M = 2.77$, SD = 1.07). In total, 52% of older adults in the control condition either agreed or strongly agreed that they found the task to be difficult compared to 33% in the Stereotype Threat condition. On the other hand, 43% of older adults in the Stereotype Threat condition reported either disagreeing or strongly disagreeing that they found the task

Table 2
Average driving mistakes of participants by testing condition according to their domain identification ratings (very important or extremely important).

Condition by domain identification	Mistakes	
	Mean	SD
Experimental × domain identification (extremely important)	12.94*	1.34
Control × domain identification (extremely important)	6.58*	1.60
Experimental × domain identification (very important)	11.42	1.60
Control × domain identification (very important)	13.20	1.75

* $p < .05$.

Table 3
Participants' follow-up responses regarding their testing experience.

Question	Condition	Answers (%)		
		Strongly disagree–disagree	Neither agree or disagree	Agree-strongly agree
Found the task difficult	Control	14.8	33.3	51.9
	Stereotype-threat	43.3	23.3	33.3
Perceived pressure	Control	37.0	44.4	18.5
	Stereotype-threat	36.7	30.0	33.3
Task representative of driving skills	Control	29.6	18.5	52.0
	Stereotype-threat	36.7	16.7	46.7
Experimenter expected poor performance based on age	Control	77.8	22.2	–
	Stereotype-threat	70.0	26.7	3.3
Prior knowledge of older driver negative stereotypes	Control	14.8	37.0	48.1
	Stereotype-threat	23.3	26.7	50.0

difficult compared to 15% of individuals in the control group. It is also interesting to note that in response to the question pertaining to perceived pressure, 33% of older adults in the Stereotype Threat condition, compared to 18% for the control group reported agreeing or strongly agreeing that they felt under pressure to prove that older drivers were safe drivers during the simulated task. Interestingly, over 50% of participants from both group indicated that their real driving abilities were reflected in the task. The averages to the remaining post hoc questions are depicted in Table 3.

5. Discussion

Our findings illustrate that negative stereotypes of aging drivers can alter the driving reactions of older adults. Specifically, our research shows that exposure to information congruent with the negative perception of older drivers was sufficient to alter the overall performance of older drivers on a simulated driving task. This latter result confirmed our main hypothesis that older adults under the Stereotype Threat condition are more likely to make driving mistakes than older adults not exposed to such threatening information.

The differences in driving reactions observed are quite remarkable especially given our subtle induction of Stereotype Threat. One could hypothesize Stereotype Threat's influence would be compounded on the road because our manipulation (i.e., presentation of information) is arguably less "threatening" than what is experienced by older drivers on a daily basis (i.e., aggressive on-road behaviors by other on-road users, and media reports questioning their ability to drive their vehicle). Furthermore, the presence of a significant result in this simulated context seems very telling considering that older adults in this sample were highly functional, in good health and highly educated (69% of older adults of this study had post-secondary education). Moreover, these participants certainly showed high confidence in their driving abilities as they self-selected for this study. If Stereotype Threat was able to alter the performance of this resilient group of older adults who had numerous protective factors against Stereotype Threat, one could hypothesize that its impact would be magnified in the general population of older adults.

Contrary to what was expected however, participants in the Stereotype Threat condition were not more likely to crash during the *Car Overtaking* surprising event scenario. This result is inconsistent with prior research indicating that Stereotype Threat tends to be more salient during difficult tasks (Steele et al., 2002). This finding is also surprising as it differed from the results of Yeung and von Hippel (2008) who observed women's driving performance could be altered by Stereotype Threat during complex situations. The lack of differences in regards to collisions could indicate that the *Car Overtaking* scenario was not sensitive enough to detect the impact of Stereotype Threat. Furthermore, the discrepancy with the Yeung and von Hippel (2008) result could derive from important methodological differences. In their study, participants received the "threatening" information from a video recording of an individual pretending to work for a transportation research center. In contrast, in our study, the information was displayed on the simulator screen. The use of this "expert" to convey the stereotypical information could have made the threat more blatant in their study compared to ours, which might have enhanced the differences between the two groups. However, their driving course appeared less complex then the one used here (e.g., lower speed limits, less traffic, and no intersections) which limits the comparisons that can be made.

On the other hand, while speculative, one could hypothesize that the discrepancies of our findings with previous research imply that Stereotype Threat could affect different driving behaviors depending on the population studied and the nature of the stereotype itself. One could hypothesize that the Stereotype Threat had more impact on the speed of older adults (i.e., compared to women in Yeung and von Hippel, 2008) because older adults tried to compensate for the predominant negative view that older drivers are slow drivers. Given their pre-existing knowledge of the older driver stereotype, older adults might have wanted to drive faster on the simulator that they normally would, to ensure they would not "confirm" the negative stereotypes (i.e., overly cautious and slow) pertaining to their group. This seems plausible given that previous research on older drivers has found that older adults tend to drive slowly in simulation contexts (Hakamies-Blomqvist et al., 2001; Toxopeus, 2007, as cited in Mullen et al., 2011). Hence, some driving behaviors might be more susceptible to Stereotype Threat when individual factors such as gender and age of the participants are considered.

The significant interaction found between condition and domain identification on driving reactions further highlights the necessity to consider how personal characteristics can moderate the influence of contextual factors on performance. More precisely, our results suggest that in the absence of induced threat (as it was the case in the control group), finding driving extremely important could enhance one's motivation to perform well on the task. One could hypothesize that, compared to individuals exposed to the threat these individuals were able to frame the task as a challenge versus a threatening examination, which could explain their performance on the simulated driving task. In contrast, in the presence of threat, being extremely identified to driving seemed to have rendered one more susceptible to the detrimental consequences of the threat. The moderating effect of domain identification is consistent with the Stereotype Threat literature specifying that

individuals who value the domain targeted by Stereotype Threat are more likely to show decrements in performance (Chasteen et al., 2005; Hess et al., 2003; Schmader, 2002). The finding that domain identification might heighten one's sensitivity to Stereotype Threat is concerning, given that for most older drivers, driving is related to their self-worth, identity, independence, and socialization (Donorfio et al., 2009; Eisenhandler, 1990; Rudman et al., 2006; Yassuda and Wilson, 1997). Therefore, it seems appropriate to conclude that many older adults are at risk of showing performance decrements under contextual threats.

While domain identification might be a risk factor, education seems to protect from the detrimental influences of Stereotype Threat. Although not statistically significant, we observed that highly educated individuals made somewhat fewer mistakes than less educated participants. This influence of education is consistent with the results of Andreoletti and Lachman (2004), who found that education could render one less susceptible to Stereotype Threat on memory tests. However, it seems important to note that others have found that highly educated older adults can be more affected by Stereotype Threat (Hess et al., 2009). In their study, Hess et al. (2009) found that Stereotype Threat negatively influenced the memory performance of highly educated older adults. The dual role of education might be better understood when domain identification is also considered. Specifically, Hess et al. (2009) posited that individuals with higher education might value more their memory abilities than less educated individuals, hence increasing their vulnerability to Stereotype Threat. In light of Hess et al.'s (2009) proposal, we speculate that driving, compared to cognitive skills, might be more valued by older adults with less education, making them more susceptible to Stereotype Threat. This interaction hypothesis between condition, domain identification, and education needs to be explored in subsequent studies.

Additionally, given that our study has shown that individual characteristics seem to interact with Stereotype Threat, future studies should also investigate the potential moderating role of self-regulation. As suggested by the findings of Gaillard et al. (2011), it would be worthwhile to identify if, when exposed to negative information regarding their driving abilities, prevention-focused older adults are more susceptible to negatively alter their driving behaviors (i.e., make more mistakes or be overly cautious), compared to when they are exposed to positive stereotypic expectations.

Some methodological limitations have to be considered. While the simulator sickness rates obtained in this study are comparable to those of previous studies (see Mullen et al., 2010), the sample attrition in this study due to simulator sickness was elevated. Importantly, we found that there were no differences between completers and non-completers on important demographic variables. Nonetheless, one could wonder if the participants who failed to complete the simulated task were different from those who did on important variables not captured in this study, which could affect the representativeness of our sample. For example, Mullen et al. (2010) observed that individuals who had to drop out given simulator sickness had better on-road driving performance than individuals who completed the simulated task. Therefore, one should keep in mind the potential consequences of attrition when interpreting this type of findings.

Other limitations in regards to our sample also need to be noted. Firstly, our sample size was smaller than initially anticipated, which minimized the observed power. Consequently, other significant differences on the driving performance of older drivers might have been more apparent with a larger sample size. This lack of power could explain why we no longer observed a significant main effect of Stereotype Threat when exploring the moderating influences of domain identification and education. As the main effect of Stereotype Threat was at the cusp of significance in the t-test analysis ($p = .04$), the addition of a factor in the ANOVA might have influenced the distribution of the error term, rendering our main effect non-significant. Nonetheless, one could also hypothesized that this result reveals that, when studying the influence of Stereotype Threat on the performance of older drivers, what is most interesting is not the main effect of Stereotype Threat itself, but the interaction between the threat and individual variables, such as domain identification. This result could further support our claim that the exploration of moderating and mediating factors is extremely important if we which to better our understanding of older drivers' performance. Additionally, we would have liked to have an equal number of women and men in our sample. Failure to do so seems nevertheless understandable, given the performance domain assessed (driving); in today's older adult population, there are still more men than women with a valid driver's license (Rosenbloom, 2003).

Given the subtlety of our manipulation, we propose that a stronger stereotype induction, such as those encountered in real on-road environments, would strengthen the results observed. We also believe that a real-world context (i.e., assessment of driving abilities) could heighten the threat experienced by older adults. For example, upon entering a driving assessment facility for a mandatory age-related driving examination, older adults might already be under some Stereotype Threat. In light of this proposal, we wonder if the laboratory context used in this study could have mimicked the naturalistic driving assessment context, and thus generated an unintentional "threat". Specifically, the impact of the Stereotype Threat manipulation on driving performance observed in this study, as reported by the effect sizes, was not as strong as hoped. The laboratory context could have generated a Stereotype Threat for both groups prior to the experimental induction of the threat and attenuated our results. As Jamieson and Harkins (2010) indicated, in order for Stereotype Threat to occur, one needs to "know" that one's group is stigmatized and "be" a member of the stereotyped group (i.e., aware of their membership to the group). It seems that for most of our participants, these two pre-requisite could have been met before we explicitly induced Stereotype Threat via our experimental manipulation. More specifically, answers on the follow-up questionnaire revealed that numerous participants "knew" that older drivers were negatively stereotyped prior to testing and participants were aware they "were" from the targeted group as they had been selected for this study based on their advanced age (i.e., recruitment targeted older adults). The presence of high crash rates on the surprising event (i.e., almost one out of two participants, regardless of the testing condition) could also support our claim of a threat induced by the laboratory context and recruitment measures. Prior findings further support this hypothesis, as simply identifying oneself with a stigmatized group on a sociodemographic questionnaire seems sufficient to disrupt performance (Bosson et al., 2004). If such a subtle cue could induce Stereotype Threat, it appears likely that coming to a University driving laboratory for a driving study that recruits older adults could generate a contextual pressure sufficient to disrupt performance. However, this needs to be further explored.

5.1. Conclusion

The influence of negative stereotypes on the driving reactions of older adults observed in this study adds to previous work revealing that external factors can influence driving performance of older adults. Our findings support the claim of Lindstrom-Forneri et al. (2010) that comprehensive models of older drivers' performance should include global factors such as social policies, laws, and negative stereotypes of older drivers. At the practical level our study reveals that policy makers, government agencies, and the media should intervene at a social level to help change perceptions regarding older drivers. Policy makers should be aware of the possible

negative effects of heightening age-related stereotypical expectations through policies and regulation (e.g., requiring all people aged 80 years and above to be reassessed, regardless of actual driving performance).

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