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Modernization of the Driver Behaviour Questionnaire

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ABSTRACT

Introduction: The current study builds on previous versions of the Driver Behaviour Questionnaire (DBQ) by incorporating a larger sample of driving behaviors targeting inattention, distraction, aggressive driving, and health related to aging. The goals of this study were to determine if the resulting factor structure was consistent with a more contemporary view of unsafe driving behaviors, and to determine whether scores on the factors could predict self-reported collisions and police citations.
Methods: The instrument was given to a sample of 3295 drivers ranging in age from 19 to 80+ years old. It was divided in two sections, the first to provide demographic information and driving history data and the second containing 105 driver behavior questions.
Results: An exploratory factor analysis resulted in a 65-item scale organized in four factors. The factors were labeled tentatively as *Inattention Errors*, *Age-Related Problems*, *Distraction and Hurry*, and *Aggressive Violations*. Regression analyses showed that the factors were predictors of self-reported, at-fault collisions and police citations.
Practical implications: The factor scores found in this research are consistent with a useful theoretical framework for understanding unsafe driver actions, and demonstrate some potential to identify several individual difference variables that predict self-reported collisions and citations.

1. Introduction

Drivers often engage in behaviors that pose a risk to both themselves and to other road users. While many of these unsafe actions are active, conscious rule violations, others are the result of errors due to inexperience, momentary mistakes, inattention or functional decline, the latter often related to age. Intentional or not, these behaviors can and do contribute to traffic collisions (Stanton and Salmon, 2009; Wierwille et al., 2002). Because of this, there is a need for tools that can measure these behaviors and the frequency with which they are exhibited, and that can determine which specific actions predict traffic collision involvement. There are a variety of tools used to such ends, including epidemiological analysis of collision data, naturalistic, quasi-naturalistic and simulated driving performance and self-report measures of those driving behaviors believed to be causal in crashes (for a brief review, see Castro, 2009).

For more than two decades, there has been a body of research published regarding the creation, modification and evaluation of one such tool, widely known as the Driver Behaviour Questionnaire (DBQ). In 1990, Reason et al. introduced the 50-item self-report instrument, in which drivers rated the frequency of risky behaviors engaged in while driving. Winter and Dodou (2010) identified almost two hundred studies that have used the DBQ in part or in its entirety. af Wåhlberg et al. (2011) concur that the DBQ is one of the most widely used instruments for measuring driving behavior.

Since the time of its creation, there have been significant changes to both the driving population and the driving environment. In most developed countries, population aging has meant that while novice and younger drivers continue to use the roadways in large numbers, there are proportionately more older drivers whose driving difficulties are distinct from those of their younger counterparts (Boot and Scialfa, 2016). Additionally, there is increased recognition that distraction, inattention and aggressive behavior are critical causal factors in crashes and untoward driving events (see Regan et al., 2013; Stanislaw, 2012). As such, the behaviors sampled in the original DBQ may be inadequate to capture the actions that increase driver risk and may not be targeted to best remediate problematic behaviors.

The purpose of this study was three-fold. First, we supplemented currently available versions of the DBQ to sample more adequately the constructs of inattention, aggressive driving, and problems produced by functional decline most commonly related to aging. We then determined if the resulting factor structure was consistent with a contemporary view of risk-inducing driving behaviors. Secondly, we evaluated whether the resulting factor structure was

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related to demographic variables such as gender and age. Finally, we examined the predictive value of these factors when the outcome variables were self-reported, at-fault collisions and police citations.

1.1. Emerging factors in driving risk

Traffic safety researchers have focused increasingly on the importance of inattention generally and distraction more specifically as causal to collisions (McKnight and McKnight, 2003; Redelmeier and Tibshirani, 1997). Though statistics vary, some studies indicate that 25–30% of police-reported traffic crashes in the United States are related to driver inattention (Klauer et al., 2010). There is currently no universal agreement on what constitutes inattention, but there is some consensus (Lee et al., 2009) that inattention involves the failure to allocate visual and cognitive processes adequately to the driving task. Inattention can result from a variety of sources inside the vehicle, in the external driving environment or within the individual. Some of the most frequently examined sources of inattention are technology-based activities such as cell phone use (Caird et al., 2008; Redelmeier and Tibshirani, 1997), text-messaging (Hosking et al., 2009) and navigational systems (Tijerina et al., 1998). Epidemiological and more naturalistic field studies indicate that compared to older drivers, younger adults are more likely to engage in these distracting activities (e.g., Rudin-Brown et al., 2013). This will likely change as the present young adult cohort ages while accustomed to and, perhaps, dependent on these technologies. And, it is likely that these sources of inattention will be even more problematic for older drivers (Boot and Scialfa, 2016).

Even in the absence of disease, aging brings with it considerable changes in perception and cognition that are relevant to driving performance and collision risk (Scialfa et al., 2004; Scialfa and Kline, 2007). These include declines in acuity and contrast sensitivity, increased sensitivity to glare, diminished peripheral vision, slower response times and greater costs of attentional task demands. Many of these changes increase the vulnerability of older drivers, particularly in complex driving tasks (e.g., intersections) and have been found to predict driving performance (Jones Ross et al., 2014; Wood et al., 2013). There have been several attempts to develop self-report instruments focusing on visual perception (e.g., problems with glare or making left turns) that capture and quantify driving problems experienced by older adults (Owsley et al., 1999; Kline et al., 1992), but these have not found widespread use in the traffic safety literature. Although the original DBQ has been used with older drivers (Parker et al., 2000), the instrument was not designed specifically to measure behaviors related to the difficulties they experience.

Among the risk-inducing behaviors that are less common in older adults, one is aggressive driving. While the definition and operationalization of aggressive driving is open to debate (Stanislaw, 2012), it is believed to be captured in actions such as honking at other drivers when irritated and driving at unsafe following distances to maintain high speeds. The media often report dramatic incidents of aggressive driving under the heading of "Road Rage", but less violent examples (e.g., "tailgating") are much more common and clearly increase the likelihood of adverse events on the roadway (Deffenbacher et al., 2003). Using a variety of scales to measure aggressive driving, the general finding is that these types of behaviors are more common in males and less frequent in older adults (Lajunen et al., 1998; Maxwell et al., 2005; Shinar, 1998). Clearly, any instrument intended to sample behaviors related driving risk must include items related to anger, aggression and hostility.

1.2. The evolving Driver Behaviour Questionnaire

The Driver Behaviour Questionnaire (DBQ) was developed by Reason et al. (1990) and refined by Parker et al. (1995). It is a self-report tool in which drivers rate the frequency of risk-elevating behaviors committed while driving. Its original purpose was to determine whether the distinction between errors and violations would surface, because of the belief that these two types of behaviors hold psychologically distinct origins, and thus would require separate techniques of remediation. Errors were defined as "the failure of planned actions to achieve their intended consequences" (p. 1315), while violations were defined as "deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system" (p. 1316). Errors were decomposed further to include slips and lapses, "the unwitting deviation of action from intention" (p. 1315), and mistakes, considered "the departure of planned actions from some satisfactory path toward a desired goal" (p. 1316).

Since its creation, the DBQ has been modified, updated and adapted for a variety of driving environments and populations (e.g., Aberg and Rimmö, 1998; Bener et al., 2008). A structure comprised of *Slips/Lapses*, *Mistakes*, *Ordinary Violations*, and *Aggressive Violations* has been broadly replicated, although the distinction between *Ordinary* and *Aggressive Violations* is not always obtained at the factor or component level (Lajunen et al., 2004; Lawton et al., 1997; Parker et al., 1995, 2000; Rimmö, 2002).

The inattention factor was explicitly incorporated into the DBQ by Aberg and Rimmö (1998), who added new items to the original scale. A four-factor solution identified *Violations*, *Mistakes*, *Inattention Errors* and *Errors by Inexperience*. *Inattention Errors* were significantly higher among the older drivers. The French version of the DBQ, developed by Guého et al. (2013) also revealed an *Inattention Error* factor that was of larger magnitude among females and drivers with less experience.

Similarly, Verschuur and Hurts (2008) developed a model that explains safety-related driver behavior. Based on DBQ studies, the authors argued that unsafe acts leading to collision involvement are of three types; violations, dangerous errors, and inattention errors. In a sample of 743 Dutch drivers, they measured the frequency of collision involvement in the last three years, active failures (from the DBQ), and items related to strategic decisions and psychological and physical precursors. Their findings suggest that collision involvement is predicted by four specific variables: driving under unsafe conditions, violations, Inattention Errors, and dangerous errors.

Rather than focusing on collisions, Rimmö and Hakamies-Blomqvist (2002) gathered data on self-imposed driving restrictions in a sample of 939 Swedish drivers who were given the Swedish version of the DBQ along with a questionnaire concerning19 specific health issues (e.g., thyroid dysfunction or cataract). They reported that while age and gender were important predictors, problems with inattention, inexperience and impaired health were related to voluntary limitations to driving. Most of their older adults reported themselves to be in good health: It is reasonable to expect that medical fitness would be an even more important predictor of driving behavior in those who are less healthy. For example, compared with healthy older adults, those with a diagnosis of mild dementia are more likely to be rated as "unsafe" in a standardized on-road driving assessment (Duchek et al., 2003).

Recently, Cordazzo et al. (2014) carried out a replication of the original DBQ, developed by Reason et al. (1990) and Parker et al. (1995) in a North American life-span sample of adult drivers. The results revealed a three-component structure of *Lapses*, *Errors* and *Violations* as reported by Parker et al. (1995), but these components had limited ability to predict self-reported collisions. The authors pointed to the need to incorporate more items to address some behaviors and contexts that are not well sampled in the original scales, items concerned with the constructs of driver inattention, distraction, aggression and problems in perception and cognition.

1.3. Synthesis and rationale for the present study

The DBQ has been used with considerable frequency and some success in capturing driver behaviors that increase the risk of collision. That being said, its predictive utility is not great (af Wåhlberg et al. (2011) and there is sparse sampling of increasingly common behaviors related to inattention, distraction and aggression that are causal to collisions. In addition, the instrument does not target those behaviors that are linked to functional changes in older adults, changes that render them more vulnerable as drivers, particularly under more demanding driving conditions such as driving at night. These shortcomings lead to an instrument that, while adequate to the general driver of the 1990s, may not reflect changes in driving behavior or the aging of the population.

In the present study, we report additional analysis from the data gathered by Cordazzo et al. (2014). In that study, added to the original DBQ were items to better reflect inattention and aggressive driving, As well, we asked about behaviors associated with age-related changes in vision and memory that increase vulnerability “behind the wheel”. It was thought that the resultant factor structure would reflect these known contributors to driving risk and might also predict self-reported, at-fault collisions and violations.

2. Methods

2.1. Participants

The sampling strategy was intended to gather data from across the age span of current drivers in numbers similar to the current driving population, based on data from the U.S. Census Bureau (2012), and Statistics Canada (2014). The instrument was distributed in two separate mailings to 15,000 randomly selected, currently licensed Alberta Motor Association (AMA) members over 30 years of age. Because of the lack of younger drivers in the AMA membership rolls, we collected additional younger driver data from the undergraduate student population at the University of Calgary. Participants in this convenience sample held a valid driver’s license, were enrolled in psychology courses, and were given course credit for their participation. There was no monetary compensation or inducement provided for responding.

Of the 15,000 questionnaires distributed to AMA members, 19.35% (N = 2902) were completed and returned. Reflecting the population distribution of the province, 68% came from people in the Calgary or Edmonton areas. Those participants from the AMA sample under the age of 30 years (N = 29) or missing data on age (N = 27) and participants without a valid driver’s license (N = 7) were excluded. Thus, the AMA sample contained data from 2839 drivers. An additional 484 University of Calgary students completed and returned the survey. From the student sample, participants over the age of 30 years (N = 23) or missing data on age (N = 5) were excluded from analyses, yielding 456 respondents. Table 1 provides the percentage of participants by age and gender in both samples.

In the AMA sample, approximately one-half (53.9%) of the respondents were females. Drivers were, on average, 60.65 years old (SD = 13.81 years). They rated themselves as generally healthy, with an average of 4.04 (SD = .76) on a scale of 1 (very poor) to 5 (excellent). They had held a valid license for a mean duration of 41.39 years (SD = 13.77 years). Most of the participants (72.4%) reported their annual driving distance to be between 5000 and 25,000 km/year. Some 13% indicated that they had experienced at least 1 collision in the past 2 years.

In the student sample, 42.8% were female with a mean age of 20.95 years (SD = 2.16 years). They had held a driver’s license for an average of 3.72 years (SD = 2.25 years). In 68.9%, their self-reported annual distance driven was between 5000 and 25,000 km/year. By self-report, like the AMA sample, their general health was quite good (M = 4.35, SD = .69). Reflecting the greater collision risk among younger drivers, 26.7% (N = 122) reported that they had experienced at least 1 collision in the past 2 years.

This study was approved by the Conjoint Faculties Research Ethics Board (CFREB) of the University of Calgary (File # 7207).

2.2. Instruments

The questionnaire was divided in two sections. The first contained 21 demographic questions regarding age, gender and level of education. We also gathered information about their years of licensed driving experience, estimated annual distance driven (a 6-category ordinal item), normal driving environment (e.g., urban or rural), at-fault collisions and police citations in the past two years, including the specific infraction. With regard to health, participants were asked if they were currently being treated for the most common health problems in adulthood (e.g., diabetes, hypertension, dementia) and if they suffered from common visual impairments (e.g., glaucoma, cataract).

The second section was composed of 105 driver behavior questions. There was minimal context provided to respondents prior to their completing the questionnaire. They were simply told that, “We want to know about your current driving behavior, so please answer the questions based on your driving behavior in the past 2 years.”

The scale construction started from 82 items that were selected from previous versions of the DBQ (Lajunen et al., 2004; Lawton et al., 1997; Ozkan et al., 2006; Parker et al., 1995, 2000; Reason et al., 1990). From those items, 19 were retained *verbatim*, 46 were modified in wording to ensure clarity, 17 items were omitted because they were not relevant for the North American context (e.g., “Forget which gear you are currently in and have to check with your hand”), and 27 new items were related to inattention, aggression or Age-Related Problems associated with driving (Kline et al., 1992). Additionally, 13 previously published DBQ items with reversed wording were added to encourage respondents to read each question more carefully and to avoid the response biases in single-valence tests (Allen and Seaman, 2007).

After pilot testing all items on a small sample of 20 specialists in driving, psychology and scale construction, 5 items were added and 6 items were omitted for reasons of clarity. Responses were recorded on a 6-point, Likert-type scale with the following anchors; never, very rarely, occasionally, often, nearly all the time, and always. The complete list of items and their changes from the original can be obtained on request from the authors or in Cordazzo et al. (2014).

3. Results

In order to maintain sample size, missing data (.8%) were replaced with the mean of each variable, from the entire sample, without any imputation based on other data. Analyses were conducted using SPSS Version 20.

Items that were reverse-coded, when transformed for comparison, were found via t-tests to yield significantly different responses (p < .001) from their conventionally worded counterparts on 12 out of 13 pairs of items that were substantively identical. The direction of the difference was positive for some of the items (N = 8) but negative for others (N = 5). This suggested that participants had difficulties responding to reverse-coded items. As a consequence,

Table 1
Percentage of participants by age in decades and gender in each sample.

Age	Student sample (N = 456)		AMA sample (N = 2839)						Total
	<19	20–29	30–39	40–49	50–59	60–69	70–79	80+	
Male	2.4	5.4	1.9	4.7	9	10.5	9.6	4.1	47.6
Female	1.1	4.8	4.7	7.4	13.1	10.1	7.5	3.8	52.4
Total	3.5	10.2	6.6	12.1	22.1	20.6	17.1	7.9	100

reversed items were eliminated (N = 13) and the original items were retained, resulting in a 92-item instrument. Although this may seem problematic, it is worth noting that neither the original DBQ, nor its most common modifications have used reverse-coded items.

Among the 65 items retained in the factor analyses because they had loadings of .3 or greater, the five items with the highest reported means were: "Drive faster than the speed limit on a highway" (M = 2.88, SD = 1.27), "Purposely avoid busy or complex roads and intersections" (M = 2.82, SD = 1.31), "Drive with only one hand on the wheel" (M = 2.78, SD = 1.27), "Eat or drink while you are driving" (M = 2.60, SD = 1.09), "Driving while looking at a map or GPS device, changing the radio station, etc. (M = 2.39, SD = 1.10).

The five items with the lowest means were: "Feel angered by another driver's behavior and chase after him/her with the intention of giving him/her a piece of your mind" (M = 1.11, SD = .43), "Get involved in unofficial races with other drivers" (M = 1.16, SD = .49), "When turning right, nearly hit a cyclist who has come up beside you" (M = 1.20, SD = .44), "On a two-lane road, attempt to pass a vehicle that you hadn't noticed was signaling its intention to turn left" (M =1.20, SD = .48), "Miss a stop sign and narrowly avoid colliding with traffic having the right-of-way" (M = 1.22, SD = .48).

3.1. Factor analysis

The responses to the 92 items were subjected to an exploratory factor analysis, using maximum likelihood extraction with oblimin rotation. Maximum likelihood was our preferred method, given that it accounts for error in measurement and correlations between items (Costello and Osborne, 2005; Fabrigar et al., 1999). Further, although varimax rotation is the most commonly utilized rotation technique because it produces easily interpretable results (Costello and Osborne, 2005), it imposes an unrealistic assumption of orthogonality of the emerging factors. Because preliminary analysis showed that the factors were correlated, the data were best suited to an oblimin rotation. Moreover, it has been argued that the use of orthogonal rotation when factors are correlated can result in the loss of information, making an oblimin approach desirable (see Costello and Osborne, 2005 for a discussion).

We used the criterion of unity in our preliminary analysis, only extracting factors that had eigenvalues greater than 1 (Kaiser, 1960). It resulted in a 65-item scale, and 4 factors were extracted from the analysis, accounting for 28.49% of the initial variance and 25.37% of the variance after rotation. Table 2 shows the distribution of the items and their respective descriptive data.

We labeled the first factor *Inattention Errors* because it contains items related to the failure of planned actions, due primarily to lack of attention to activities critical for safe driving. Examples of this are items such as "Miss a stop sign and narrowly avoid colliding with traffic having the right-of-way" and "Notice only too late that you drove through a red light." This factor contained 32 items and it accounted for 18.19% of the initial variance and 17.39% of the variance after rotation. Cronbach's alpha was .90.

The second factor was labeled *Age-Related Problems* because of high-loading items reflecting difficulties in visual, motor and cognitive abilities. Examples of these items are, "Have problems seeing at night because of oncoming headlights, even when they are properly dimmed" and "Purposely avoid busy or complex roads and intersections." Further justification for this labeling is that: (a) items reflect problems experienced by older adults (Scialfa et al., 2004; Scialfa and Kline, 2007); (b) there is a positive correlation between the factor and age; and (c) a similar labeling has been used in the past (Kline et al., 1992). This factor contained 6 items that accounted for 5.85% of the initial variance before rotation and 5.13% of the variance after rotation. Cronbach's alpha was .64.

We labeled the third factor *Distraction and Hurry* because it included such items as "Eat or drink while you are driving" and "Speed up in order to make it through yellow lights." These items are a mixture of errors and deliberate deviations from practices necessary to safe driving and indicate a diversion of attention toward a competing activity or hurry. This factor contained 20 items and it accounted for 2.40% of the initial variance and 1.60% of the variance after rotation. Cronbach's alpha was .90.

We labeled the fourth factor *Aggressive Violations* because of the high loading of items that are related to deliberate deviations from safe driving due to an emotional component. This factor includes items such as "Sound your horn to indicate your annoyance to another road user" and "Get told by a passenger to calm down because you are angry at other drivers." This factor included 7 items. It accounted for 2.05% of the total initial variance and 1.25% of the variance after rotation. Cronbach's alpha is .68.

Table 3 presents means and standard deviations for each factor. Factor scores were estimated by summing raw scores corresponding to the items loading on each factor. The correlation matrix of the factors is presented in Table 4. All factors are positively correlated, except *Aggressive Violations* and *Age-Related Problems*.

3.2. The influence of demographic variables

In separate simple regression analyses, factor scores were linearly regressed on the major demographic variables collected. Table 5 indicates that gender is a significant predictor of *Age-Related Problems*, *Distraction and Hurry* and *Aggressive Violations*. Males are more prone to have higher scores on *Distraction and Hurry* and *Aggressive Violations*, while women had higher scores on *Age-Related Problems*. Age is a significant predictor of all four factors. The older the driver, the lower the scores on *Inattention Errors*, *Distraction and Hurry* and *Aggressive Violations*. As was expected, *Age-Related Problems* scores were higher in older adults. Finally, people who drove more kilometers per year had higher scores on *Distraction and Hurry* and *Aggressive Violations* factors and lower scores on *Age-Related Problems*.

3.3. Predictions of at-fault collisions

Because the vast majority of respondents reported either no or one at-fault collision, logistic regression was used to ascertain the predictive utility of the factors with respect this outcome, treated as a dichotomous variable. The models tested were of three types, in ascending level of complexity. First, we examined the effects of each factor alone. In the second step, each factor was assessed after

Table 2
Four-factor solution with descriptive data and loadings.

Items	*M* (SD)	Factors			
		1	2	3	4
52. Misjudge the distance between oncoming vehicles when turning left and narrowly miss a collision (M)	1.34 (.51)	.601			
50. Ignore a yield sign and almost collide with traffic having the right-of-way (OV)	1.25 (.47)	.587			
56. Miss a stop sign and narrowly avoid colliding with traffic having the right-of-way[a]	1.22 (.48)	.553			
79. Fail to notice pedestrians crossing when turning into a side-street from a main road (S/L)	1.53 (.58)	.526			
67. Fail to notice someone stepping out from behind a bus or parked vehicle until it is nearly too late (S/L)	1.48 (.57)	.522			
37. Underestimate the speed of an oncoming vehicle when passing on a two-lane highway (M)	1.63 (.64)	.489			
42. Get into the wrong lane when approaching an intersection or roundabout (M)	1.72 (.74)	.487			
44. Notice only too late that you drove through a red light (S/L)	1.43 (.56)	.483			
38. When merging into traffic, get "surprised" by a vehicle that you didn't notice until it was quite close to you (S/L)	1.93 (.63)	.479			
96. Turn left into the path of an oncoming vehicle that you hadn't seen (S/L)	1.32 (.51)	.476			
82. Follow another vehicle into an intersection without realizing that the light has changed to red[a]	1.37 (.55)	.473			
81. Forget that you have your high beams on until 'flashed' by other motorists (S/L)	1.71 (.64)	.438			
43. Fail to check your mirrors before pulling out, changing lanes, turning, etc. (S/L)	1.57 (.82)	.427			
70. Fail to notice someone waiting at a crosswalk (V)	1.82 (.63)	.426		−.318	
62. Mistakenly stop or brake at a green light	1.42 (.59)	.421			
75. In a line of cars turning left onto a main road, pay such close attention to the main stream of traffic that you nearly hit the car in front of you (S/L)	1.39 (.58)	.411			
93. Fail to signal when you are making a lane change	1.61 (.69)	.404			
77. Fail to yield to traffic coming from the right at an uncontrolled intersection[a]	1.40 (.62)	.403			
72. Fail to signal your turn when approaching an intersection[a]	1.48 (.65)	.396			
51. Fail to notice when a traffic light turns green[a]	1.71 (.64)	.392			
46. Brake too hard on a slippery road or steer the wrong way in a skid (M)	1.58 (.63)	.391			
59. Turn into the wrong lane when completing a left turn[a]	1.68 (.74)	.391			
23. Forget to turn off your "turn" signal	1.85 (.70)	.389			
31. When turning right, nearly hit a cyclist who has come up beside you (M)	1.20 (.44)	.383			
85. Find yourself straying out of your lane[b]	1.54 (.61)	.379			
25. Fail to see a playground or school zone sign	1.88 (.71)	.375		−.300	
69. Hit something when backing up that you did not see (S/L)	1.33 (.52)	.372			
80. Find yourself driving too fast when approaching an intersection and have to brake hard to stop[a]	1.87 (.65)	.370			
65. Find yourself stopped in the middle of an intersection or in a pedestrian crosswalk because of stopped vehicles ahead[a]	2.20 (.76)	.365			
105. Realize that the vehicle ahead has slowed, and have to slam on the brakes to avoid a collision because you were distracted or preoccupied (S/L)	1.79 (.67)	.338			
26. Misjudge the space available in a parking lot and nearly (or actually) hit another vehicle (M)	1.27 (.51)	.336			
63. On a two-lane road, attempt to pass a vehicle that you hadn't noticed was signaling its intention to turn left (S/L)	1.20 (.48)	.306			
84. Avoid driving at night[b]	2.10 (1.32)		.642		
99. Purposely avoid busy or complex roads and intersections[a]	2.82 (1.31)		.608		
102. Have problems seeing at night because of oncoming headlights, even when they are properly dimmed[b]	2.38 (1.07)		.572		
107. Forget where you parked your car (S/L)	2.09 (.89)		.372		
103. Switch on one thing, such as the headlights, when you meant to turn on something else, such as the wipers (S/L)	1.64 (.71)		.321		
27. Go out of your way to avoid having to make a left turn[a]	1.66 (.94)		.306		
58. Drive while looking at a map or GPS device, changing the radio station, etc. (OV)	2.39 (1.10)			−.680	
106. Eat or drink while you are driving	2.60 (1.09)			−.628	
73. Drive faster than the speed limit on a highway[c]	2.88 (1.27)			−.628	
68. Search for something in the car while you are driving	1.90 (.83)			−.575	
97. Drive with only one hand on the wheel	2.78 (1.27)			−.575	
125. Drive too fast in a parking lot (over 15 km/h)	1.84 (1.00)			−.573	
111. Drive when you are drowsy	2.02 (.85)			−.549	
83. Talk on your hand-held cell phone when you are driving	1.56 (.84)			−.525	
74. Speed up in order to make it through yellow lights (OV)[a]	2.38 (1.00)			−.514	
113. Text message, email, etc. while driving	1.36 (.79)			−.498	
33. Deliberately disregard the speed limit late at night or very early in the morning (OV)	1.85 (1.06)			−.454	.314
95. Stare at a crash or spectacle you are passing	2.38 (1.01)			−.447	
94. Realize you have no clear recollection of the road along which you have just been traveling (S/L)	1.81 (.84)			−.402	
104. Fail to check your rear-view mirror before braking	2.39 (1.13)			−.388	
78. Make an illegal U-turn at an intersection (OV)[a]	1.69 (.75)			−.388	
122. Attempt to turn a corner at too high a speed	1.58 (.65)			−.385	
86. Drive faster than the speed limit in a playground or school zone	1.60 (.71)			−.375	
34. Miss a sign or a turn because you were talking to a passenger	1.90 (.70)			−.359	
120. Pay more attention to buildings or billboards you are passing than the road in front of you	1.71 (.73)			−.358	

Table 2 (*Continued*)

Items	M (SD)	Factors			
		1	2	3	4
100. Have to brake in the middle of a curve or on a ramp because you are driving too quickly	1.98 (.75)			−.323	
112. Drive especially close to or 'flash' the car in front of you to try and get them to go faster or get out of your way (AV)	1.32 (.65)				.511
92. Feel angered by another driver's behavior and chase after him/her with the intention of giving him/her a piece of your mind (AV)	1.11 (.43)				.461
60. Get involved in unofficial 'races' with other drivers (OV)	1.16 (.49)				.419
45. Get told by a passenger to calm down because you are angry at other drivers	1.36 (.69)				.382
22. Try to pass in risky circumstances when stuck behind a slow-moving vehicle on a two-lane highway (OV)	1.47 (.72)				.380
54. Disregard red lights or stop signs when driving late at night along empty roads (OV)	1.23 (.57)				.357
71. Sound your horn to indicate your annoyance to another road user[c]	1.83 (.86)				.350

Factor loadings of less than .30 were omitted for the sake of brevity. Items from Reason et al. (1990) have the DBQ factors on which they commonly load (in parenthesis): M = mistakes; OV = Ordinary Violations; AV = Aggressive Violations; S/L = slips/lapses. Items without a factor in parenthesis are newly created unless noted otherwise.

[a] Item from Caird and Kline (2004).

[b] Item from Kline et al. (1992).

[c] Item from Lajunen et al. (2004).

Table 3
Means and standard deviations of the DBQ factors.

Scale	*Mean*	*S.D.*
Full scale (65 items)	1.73	.33
Inattention Errors (32 items)	1.55	.31
Impairment Health (6 items)	2.11	.64
Distraction and Hurry (20 items)	2.03	.56
Aggressive Violations (7 items)	1.36	.38

controlling for age. Finally, the factors were tested controlling for age, gender, education level, and exposure. The rationale for this order of entry is that we wanted to know if factor scores could add predictive value when easily obtained demographic information was already in the model. If factor scores do not account for unique variance, then there may be less motivation to obtain them.

Table 6 summarizes these analyses. The first regression analyses showed that, but for *Age-Related Problems* all factors were significant individual predictors of reported at-fault collisions. The signs of the regression weights indicate that the higher the score on those factors, the more likely a reported at-fault collision. When the models controlled for age, the *Inattention Errors*, and the *Distraction and Hurry* factors added significantly to prediction success. Similar results were found when the other demographic variables were entered into the models.

3.4. Predictions of police citations

A series of linear regression analyses were carried out to determine if the number of self-reported police citations, treated as a continuous outcome, could be predicted by the factor scores alone, after controlling for age and after controlling other demographic variables. Table 7 summarizes these results. It can be seen that each factor treated as a single predictor accounted for self-reported citations. In large part, this picture does not change when age alone is controlled, or when all measured demographic variables were entered into the prediction model. The exception to this pattern is the *Age-Related Problems* factor, which does not account for a significant proportion of unique variance after controlling for age and other demographic information.

4. Discussion

Driving personal vehicles, the preferred transportation mode throughout much of the world, is also one with significant risk of injury or death. As such, there has been considerable effort made to set minimum standards for driver fitness and to identify and remediate behaviors that decrease driving safety. Among the tools developed to identify problematic behaviors, although of debatable predictive value (af Wåhlberg et al., 2011; Winter and Dodou, 2010), the DBQ stands out for its longevity and widespread use. That being said, the theoretical basis for developing the DBQ, the

Table 4
Correlations among factors.

Factors	Inattention Errors	Age-Related Problems	Distraction and Hurry
Inattention Errors	–		
Age-Related Problems	.37**	–	
Distraction and Hurry	.55**	.07**	–
Aggressive Violations	.39**	.01	.59**

** $p < .001$.

Table 5
Demographic predictors of the factors.

Predictor	Inattention Errors			Age-Related Problems			Distraction and Hurry			Aggressive Violations		
	R^2	Beta	*p*	R^2	Beta	*p*	R^2	Beta	*p*	R^2	Beta	*p*
Gender[a]	<.001	.002	.930	.043	.207	<.001	.011	−.103	<.001	.036	−.190	<.001
Age	.007	−.083	<.001	.010	.102	<.001	.321	−.566	<.001	.127	−.357	<.001
Education	<.001	.011	.535	.007	−.081	<.001	.032	.178	<.001	.014	.116	<.001
Exposure	<.001	−.020	.250	.075	−.275	<.001	.031	.176	<.001	.021	.145	<.001

[a] 1 = male, 2 = female.

Table 6
Factors as predictors of at-fault self-reported collisions.

Factor Label	Predictors								
	Factor Alone			Factor & Age			Factor & Demographics[b]		
	R^2 [a]	*Beta*	*p*	R^2 [a]	*Beta*	*p*	R^2 [a]	*Beta*	*p*
Inattention Errors	.006	.016	<.001	.038	.012	.011	.041	.012	.012
Age-Related Problems	<.001	−.008	.557	.035	.002	.905	.037	.005	.733
Distraction and Hurry	.027	.030	<.001	.039	.015	.003	.042	.016	.003
Aggressive Violations	.008	.066	<.001	.036	.020	.258	.038	.019	.305

[a] Nagelkerke R^2.
[b] Demographic variables: age, gender, education & exposure.

Table 7
Factors as predictors of self-reported citations.

Factor Label	Predictors								
	Factor Alone			Factor & Age			Factor & Demographics[a]		
	R^2	*Beta*	*p*	R^2	*Beta*	*p*	R^2	*Beta*	*p*
Inattention Errors	.013	.112	<.001	.046	.098	<.001	.069	.105	<.001
Age-Related Problems	.003	−.053	.002	.037	−.034	.047	.058	.017	.362
Distraction and Hurry	.069	.263	<.001	.072	.229	<.001	.086	.205	<.001
Aggressive Violations	.052	.229	<.001	.066	.185	<.001	.081	.166	<.001

[a] Demographic variables: age, gender, education & exposure.

distinction between errors and violations (Reason et al., 1990), may not be consistent with current understanding of several major contributors to traffic collisions; inattention, distraction, age-related driving problems and aggression. The intent of the present research was to augment the DBQ with items reflecting these constructs and examine the resultant factor structure, to determine relationships among the factors and demographic variables such as age and gender, and to evaluate their predictive utility in terms of at-fault collisions and violations.

4.1. Factor structure of the instrument

Our large sample of North American drivers, ranging from 18 years to more than 80 years of age, yielded responses that suggest a four-factor solution. We have tentatively labeled these factors *Inattention Errors*, *Age-Related Problems*, *Distraction and Hurry*, and *Aggressive Violations*. We believe that they may provide a useful theoretical framework for understanding unsafe driver actions, one that fits nicely with current views (e.g., Regan et al., 2013) and epidemiological studies (e.g., Redelmeier and Tibshirani, 1997; Stanislaw, 2012) on contributors to collisions and is sensitive to population aging, while retaining sufficient specificity at the item level to afford corrective actions.

The obtained factors reflect the importance of these constructs to an understanding of unsafe behaviors in the current and future driving population. Klauer et al. (2010) found that approximately 25–30% of traffic conflicts are related to driver inattention, but argued that the true involvement of inattention may be as high as 70%. Recent analyses of the DBQ (e.g., Rimmö, 2002) revealed evidence of this role at the factor level. Rimmö and Hakamies-Blomqvist (2002) determined that health issues predict driving cessation in older adults and aggressive behavior often increases the likelihood of unsafe driving (Deffenbacher et al., 2003).

This is not to say that interpretation of the original DBQ is erroneous. The Aggressive Violations factor is very similar to that reported earlier. Many of the items in the Inattention Errors factor are indices of Errors, Slips, Lapses and Mistakes in the previously observed factor structure (Cordazzo et al., 2014; Parker et al., 1995). Furthermore, the correlation (.55) between the Inattention Errors and Distraction and Hurry factors indicates that they have much in common. In fact, Cordazzo et al. (2014) found that a three-factor solution of Errors, Lapses and Violations accounted for the pattern of covariances in the 20 items that most closely resemble the DBQ of Parker et al. (1995).

However, when all items are considered, there is little evidence that errors, slips, lapses and mistakes are psychometrically differentiated. As well, the Distraction and Hurry factor that was observed is conceptually distinct from earlier factor analyses, manifests internal consistency, predicts collisions, and links easily to the large body of literature indicating that distraction is an important cause of crashes (e.g., Caird et al., 2008; Redelmeier and Tibshirani, 1997). Finally, the Age-Related Problems factor, which was not measured in the original DBQ, emerged as a distinct construct that is related to age and self-reported citations. It is likely this factor would demonstrate greater predictive utility in a sample of less healthy older drivers and that it will increase in importance as the driving population continues to age.

Even if the factor structure that emerged in this instrument is found to need modification, the individual items that have been added can provide important information for drivers as well as those professionals who evaluate and train them. For example, some training programs aimed at older drivers might include pedagogical or on-road components related to common visual and cognitive problems associated with age and methods to compensate for them. In a similar manner, public awareness campaigns can and do focus more concretely on behaviors known to result in inattention, distraction and aggressive driving.

Several bivariate relations obtained are worthy of mention. The finding that the factors themselves were correlated is consistent with the view that distraction is a difficult-to-define type of inattention (see Regan et al., 2013) and that aggressive behavior, which is also a "fuzzy" concept, often results from frustrated goals such as delays in travel (Shinar, 1998). As well, several correlations with demographic variables are consistent with the traffic safety and collision literature: Young people are more prone to engage in activities that draw attention from the driving task (Rudin-Brown et al., 2013), males often are found to be more aggressive than females (Stanislaw, 2012) and older adults have more health-related driving problems than their younger counterparts (Boot and Scialfa, 2016). These relations provide some evidence of discriminant validity to the factors obtained.

4.2. Predicting collisions and citations

Of equal or greater importance is that these factors predicted at-fault collisions and citations, an indication of criterion-based validity that is necessary for any instrument to gain acceptance within the research community and the general public. Tables 6 and 7 show that with the exception of *Age-Related Problems*, each factor by itself accounted for significant variance in both outcomes. The correlations were not large, but were comparable to those reported in a recent DBQ meta-analysis (Winter and Dodou, 2010). Two factors, *Inattention Errors* and *Distraction and Hurry*, were still significant predictors of self-reported, at-fault collisions even after controlling for age, education, gender and exposure. These two factors, as well as *Aggressive Violations*, accounted for unique variability in self-reported citations after controlling for these same demographic data. Thus, information about a driver's behavior adds to the ability to predict driving risk.

Notwithstanding these strengths, one could assert with some justification that even a revised version of the DBQ, used alone, is not likely to predict driving risk at acceptable levels for widespread use. The gains in predictive utility found here were small when considered against the time and resources required for implementation. Other information, likely specific to driver age, experience and health is needed. To provide a relevant comparison, Jones Ross et al. (2014) found that a combination of laboratory tests taking approximately 25 min to complete, had a Nagelkerke R^2 of .37 and predicted passing or failing an on-road test with a sensitivity of 82% and a specificity of 69%.

4.3. Limitations and future directions

Although the instrument we used has demonstrated the potential to identify several complex individual difference variables that can predict self-reported collisions and citations, it is clear that there is more development and evaluation needed before it can be considered "user-ready". Two of the factors identified, *Age-Related Problems*, and *Aggressive Violations* are not sampled with a sufficient number of questions to achieve adequate levels of internal consistency. Even though aggressive behavior on the roadway is not as common as, for example, inattention, adding items from previously developed instruments such as the Driving Anger Scale (Deffenbacher et al., 2003) could increase reliability. A similar augmentation of the *Age-Related Problems* factor could be achieved by adding health-related items known to be correlated with both age and collision involvement. It is likely these would ask respondents questions pertaining to speed of response, divided attention, working memory and executive function (see Boot and Scialfa, 2016). At the same time, it is obvious that an instrument of 100 items or more is unlikely to garner widespread use and so reducing the questions to those with significant loadings and replicating the present results in a representative sample is a logical next step in research.

Another issue is that of the criterion variable. Retrospective reports of collisions and violations are problematic, not only because respondents may not recall them or wish to minimize feelings of culpability, but also because it is not clear that factor scores estimated in the present were of like magnitude, or at least like rank-order, in the past. One cannot assume trait-like stability in these factors. For example, Deffenbacher et al. (2003) emphasized the distinction between fleeting periods of ire and more permanent anger in understanding drivers' behavior. As well, many age-related medical conditions (e.g., transient ischemic attacks or drug interactions) bring about rapid changes in physical or perceptual-cognitive function that have implications for collision risk. Clearly then, prospective studies involving repeated measurements of both the factors and driving behavior would benefit the research community and society at large.

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