

Individual Differences in Driver Inattention: The Attention-Related Driving Errors Scale

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Objectives: Driver inattention is one of the most common causes of traffic collisions. The aim of this work was to study the reliability and validity of the Attention-Related Driving Errors Scale (ARDES), a novel self-report measure that assesses individual differences in driving errors resulting from failures of attention. The relationship between driver inattention and general psychological variables that could be connected to these phenomena was also explored.

Methods: Participants were a convenience sample of drivers drawn from the general population of Mar del Plata, Argentina ($n = 301$). Drivers responded to ARDES items, a sociodemographic questionnaire, and several validation measures. The internal structure of ARDES was assessed by factor analysis and internal consistency analysis. Analysis of covariance (ANCOVA) was applied to examine differences in ARDES scores due to sociodemographic variables. Logistic regression analysis was used to determine the association between ARDES and self-reported traffic crashes and tickets. Pearson's correlations were calculated between ARDES and validation measures.

Results: Factor analysis suggested the existence of one underlying factor. The 19 items proved to have discriminative power. The scale's internal consistency was high (Cronbach's $\alpha = .86$). ARDES discriminated those who had reported road crashes and traffic tickets from those who had not. Correlations with validation measures were robust and theoretically consistent. Findings suggested that driving errors are strongly associated with general error proneness, lack of attention when performing everyday activities, and dissociative personality traits.

Conclusion: The present study provides preliminary evidence for the validity and reliability of the ARDES scores. Further validation studies should be conducted applying other methodologies and sources of information, such as traffic records, driving simulations, or naturalistic methodologies.

Keywords Driving behavior; Attention; Error proneness; Measurement

Driver inattention is one of the most common causes of traffic crashes (Klauer et al. 2006; Neyens and Boyle 2007; Stutts et al. 2001; Wang et al. 1996). Even though there is general consensus that driver distraction and inattention exert a substantial impact on road safety, agreement is still sought regarding the theoretical and functional definition of these two concepts. Such controversy is due to the complexity of the phenomenon itself, the diversity of possible approaches, and the lack of a unified theory in the attention field (Basacik and Stevens 2008; Regan et al. 2008). Along these lines, efforts to create valid and reliable measuring instruments that are able to provide parameters based on which research outcomes can be compared and integrated, and intervention results assessed, are still underway. This article proposes a novel self-report measure to assess individual differences in driving errors arising from failures of

attention. It provides preliminary evidence of the reliability and validity of this measure and discusses the potential benefits of its implementation for assessment and scientific purposes.

Noy (2001) stated that "from a traffic safety viewpoint, it may be pragmatic to define 'inattention' simply as a lack of awareness of critical information (such as a pedestrian crossing the road, a traffic signal, or a decelerating vehicle)" (p. 1539). In this case, the concept of "critical information" can be construed as that needed to drive within an acceptable safety framework, thereby preventing situations that could bring about crash risks. Indeed, this is a broad and practical definition that focuses on the visible consequences of inattention, regardless of its cause. Failure to notice a pedestrian crossing the road or a decelerating vehicle may result from unexpected or unforeseen events diverting the driver's attention away from the driving task or from focusing attention on secondary activities (such as talking on a mobile phone). These types of errors can also be explained by factors that alter a driver's normal functional attention and prevent him or her from properly monitoring the road and traffic environment, such as fatigue or drug use. Lastly, some drivers

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may make mistakes even under ordinary environmental and personal conditions, due to certain intrinsic variables that render them more susceptible to attentional failures (e.g., boredom proneness). All of the above-mentioned reasons are potential inattention sources and have been covered to a greater or lesser extent by the literature.

A major line of research has emerged on driver distractions. Driver distractions are considered a particular type of driver inattention, in which a given event, activity, object, or person inside or outside a vehicle compels or induces the driver to shift attention away from the driving task (Treat, 1980, as cited in Young and Regan 2007). Distractions have been mainly approached by the literature from cognitive models and dual-task paradigms, and by using driving simulators (see Regan et al. 2008). In this framework, the aim is mainly to identify factors increasing distraction probabilities, regardless of whether they arise from the road environment, the vehicle, or activities secondary to driving. The most paradigmatic example in this respect is given by studies on the role that mobile phones play on driver attention (for a review, see Caird et al. 2008). Research in this area has notably contributed to the analysis of driver inattention and has assisted in the implementation of explicit recommendations to improve road safety. Notwithstanding the foregoing, it has also been the center of adverse criticism, particularly with respect to the ecological validity of the results. Horrey and Lesch (2009), for instance, claimed that in the experimental studies on distraction, researchers usually determine when and under what circumstances a distracting task will occur. Yet, in the real world, drivers play an active part in the initiation and management of these distractions. Accordingly, those experiments that force tasks on drivers may not properly capture the adaptive potential of drivers and so may not fully translate into real-world driving performance.

Inattentive driving errors, however, may not only result from triggering events or activities but can also be ascribed to driver's attentional function being affected by a given physical or psychological condition. Certain states such as fatigue, sleepiness, or being under the influence of drugs can reduce the normal levels of situational awareness, thus increasing error risks. Specific literature on the impact of altered conditions on drivers' vigilance and sustained attention has been written in this respect (e.g., Horne et al. 2006; Moskowitz and Fiorentino 2000; Sagberg et al. 2004). Research in this field has provided the foundations for road safety interventions and legislation and has specifically addressed professional driving issues (e.g., European Transport Safety Council 2001).

As stated above, there are certain psychological traits that can give rise to greater error proneness. That would be the case of individual differences in cognitive variables, such as in the ability to focus, sustain, and shift attention, as well as in personality variables, such as boredom proneness, tendency to daydreaming, and dissociation. Though cognitive variables have been thoroughly studied, the literature has devoted little attention to personality variables. In fact, research on driving inattention and personality is scarce when compared to the substantial research

work that has been conducted in other fields (e.g., risky driving). Thus, certain key questions remain to be answered, such as: Do individuals have a stable pattern of behavior related to driving inattention? Does being an inattentive driver go hand in hand with being an inattentive individual in everyday life? Is this inattention pattern related to more structural or general personality variables? These are some of the inquiries that have motivated our research work.

INDIVIDUAL DIFFERENCES AND DRIVER INATTENTION

Previous studies refer to behavior patterns associated with driving inattention as differing from other patterns, such as risky or angry driving styles. Taubman-Ben-Ari et al. (2004) developed a measure called the Multidimensional Driving Style Inventory (MDSI) and, by means of a factor analysis, identified what they labeled a "dissociative driving style," defined as "a person's tendency to be easily distracted during driving, to commit driving errors due to this distraction, and to display cognitive gaps and dissociations during driving" (p. 325). Many of the items comprising this factor were taken from the lapses scale of the Driving Behavior Questionnaire (DBQ; J. T. Reason et al. 1990), which is an important reference when it comes to individual differences in driving errors.

From the DBQ's theoretical perspective (J. Reason 1990) lapses are a type of error that results from some attention, memory, perception, or action execution slip or from the combination thereof. Lapses can take place when the task is well known and even when it has been completely automated. This differentiates lapses from mistakes, which are part of the action planning stage and occur due to lack of knowledge or task expertise. Mistakes result from a given action plan that was not properly outlined. Lapses, in turn, entail an alteration or unexpected deviation from a plan properly conceived. In the DBQ, most items evaluating lapses serve as clear examples of situations related to inattention. This explains why some authors refer to this scale as a measure of failures of attention while driving (Reimer et al. 2005). Several studies carried out in different cultures and countries account for the existence of a lapses factor as in the DBQ, thereby demonstrating its consistency and robustness.

Notwithstanding the theoretical differences between MDSI and DBQ, both instruments furnish psychometric evidence of the existence of a factor tied to driving inattention, which can be distinguished from other dimensions of driver behavior. Nevertheless, the personality variables that could explain the individual differences noticed in this factor remain to be systematically analyzed. To begin with, it could be assumed that those individuals who are prone to inattention in their daily lives will also be inattentive while driving. If this were the case, it would come as no surprise to find that certain measures of general error proneness in daily life, such as the Cognitive Failure's Questionnaire (CFQ; Broadbent et al. 1982) or the Attention-Related Cognitive Errors Scale (ARCES; Cheyne et al. 2006), correlate with driving inattention measures. However, to the best of the

authors' knowledge, the literature has neither approached nor provided any evidence to this effect as yet.

On the other hand, it could also be presumed that attention errors in general, and driving errors in particular, can be linked to personal functional styles related to lack of alertness or attention when performing everyday activities. Wickens et al. (2008) showed that the Lapses Scale of the DBQ also correlated with the Extremely Focused Attention Scale (Lyons and Crawford 1997). In view of its content, the latter resembles a psychological absorption measure (example item: "Can you lose yourself in thought so that you are hardly aware of the passage of time?"). Cheyne et al. (2006) found that ARCES correlated negatively with the Mindful Attention and Awareness Scale (MAAS; Brown and Ryan 2003) as well as with boredom proneness, a concept that may be construed as the inability to sustain attention or to maintain engagement in an activity or interest in an object. The MAAS has also been negatively correlated with the cognitive errors measured by the CFQ (Herndon 2008) and positively correlated with measures of attentional control (Walsh et al. 2009). Other studies have also shown that boredom proneness correlates positively with cognitive failures (Wallace et al. 2002, 2003). All these studies suggest that lack of alertness, absent-mindedness, and propensity for boredom are clearly related to attentional failures in daily life. However, evidence of the extrapolation of these results specifically to the driving context is very sparse.

According to the literature on cognitive failures in everyday performance, driving attention could also be ascribed to certain psychopathological processes, such as dissociation (Bernstein and Putnam 1986). Despite the fact that the meaning and scope of this concept still give rise to controversy (Pérez and Galdón 2003), it is currently understood as a dimensional construct that involves experiences ranging from nonpathological manifestations such as absorption and daydreaming to more pathological ones such as identity disorder symptoms. Earlier research has revealed relatively robust associations between dissociative experiences and everyday cognitive failures (for a revision, see Giesbrecht et al. 2008). On this basis, it could be assumed that dissociative traits could be connected to errors while driving. In effect, the dissociative driving style factor of the MDSI (Taubman-Ben-Ari et al. 2004) includes failures of attention along with normal dissociative experiences, such as daydreaming while driving. Once again, to the best of our knowledge, the relationship between dissociation and attention-related errors while driving has not been examined until now.

AIMS AND HYPOTHESIS

The main objective of this study was to investigate the reliability and validity of the Attention-Related Driving Errors Scale (ARDES), a novel self-report measure that assesses individual differences in the proneness to attention-related errors while driving. We specifically referred to attention-related errors as we sought to include items reflecting nonintentional errors in performance that would result, in whole or in part, from atten-

tional failures. Even though the intent of some scales, such as the MDSI Dissociative Driving Scale or the DBQ Lapses Scale, is to measure similar phenomena, we identified shortcomings in those scales that ultimately led us to develop a new one. To begin with, when reviewing their content we detected face validity problems, mainly in the MDSI. For instance, some items do not clearly refer to attention-related errors, such as the "misjudge the speed of an oncoming vehicle when passing" item, which denotes a lack of expertise error instead. As a matter of fact, the DBQ categorizes it under such a heading. The same applies to the "Plan my route badly, so that I hit traffic that I could have avoided" item, which refers to an error in trip planning rather than to an execution error due to lack of attention. Another example of a content problem was detected in the "I daydream to pass the time while driving" item. We believe that daydreaming can be a source of attentional failures, but that it is not an error in itself. In this sense, we argue that items should contain only errors, to avoid content overlapping with other psychological constructs (such as daydreaming, absorption, or dissociation).

Other limitations of the aforementioned instruments have to do with their layout. In the first place, and given the fact that these instruments are not specifically designed for attention-related errors, the initial instructions are too general and fail to specify some key aspects of interest to us. For example, the focus is not on the attentional nature of the errors and respondents are not given an explanation about the unintentional character of the situations presented, to clearly differentiate errors from violations (considered intentional errors; J. Reason 1990). The MDSI instructions seem even more questionable when respondents are "asked to read each item and to rate the extent to which it fits their feelings, thoughts, and behavior during driving on a 6-point scale, ranging from *not at all* (1) to *very much* (6)" (Taubman-Ben-Ari et al. 2004, p. 325). We believe that error items should be measured by using a frequency scale (e.g., from *never* to *always*).

As far as DBQ is concerned, we noticed that the Lapses Scale tended to yield low internal consistency values. In the cross-cultural study by Lajunen et al. (2003), for instance, Cronbach's alpha did not exceed .70 in any of the countries studied (values ranged from .64 to .69). We presume that this measure is too brief with respect to the extent of the content it intends to assess. The above-mentioned limitations were the main factor in motivating the development of a new measure.

As part of ARDES validation, we also intended to explore the relationship between attentional failures while driving and measures of more general psychological variables that could be related to these phenomena. Our aim was to provide external evidence of validity for ARDES scores and to open a line of research on possible psychological correlations of attentional failures while driving. Our assumption is that these types of errors are not totally situational or contextual, but rather they represent a general trend of attention error proneness. Therefore, we hypothesized that ARDES scores would correlate with general measures of cognitive errors in everyday life. In our study, we included two measures of cognitive errors in everyday life:

the ARCES and the MFS (Cheyne et al. 2006). We hypothesized a strong positive correlation between these two measures and the ARDES scores.

We also believe that driving attention errors are related to a general functioning style characterized by a lack of alertness and awareness in the performance of daily life activities. Thus, we included the MAAS (Brown and Ryan 2003), a mindfulness measure focused on the presence or absence of attention to and awareness of what is occurring in the present. It should be noted here that the MAAS does not include other dimensions or attributes tied to mindfulness, such as acceptance, trust, empathy, gratitude, etc., thus being quite appropriate for the purposes of our study. According to previous research, mindfulness is negatively correlated with error measures such as ARCES and CFQ (Cheyne et al. 2006; Herndon 2008). Along these lines, we hypothesized that ARDES and MAAS would be negatively correlated.

The relationship between ARDES and the Boredom Prone-ness Scale (BPS; Farmer and Sundberg 1986) was also analyzed. Even though no agreement has been reached in terms of the dimensionality of this scale, the most robust solution is thought to be that of two dimensions—the so-called External Stimulation (BPS-E) and Internal Stimulation (BPS-I; Vodanovich et al. 2005). The former reflects the need for variety and change, whereas the latter refers to a perceived inability to generate enough stimulation for oneself. In accordance with Cheyne et al. (2006), boredom proneness can be defined as the inability to engage and sustain attention. This explains boredom's relationship with attention error measures in daily life. Therefore, our assumption was that ARDES scores would correlate positively with both BPS subscales.

Finally, we explored the relationship between the ARDES and the Dissociative Experiences Scale (DES; Bernstein and Putnam 1986). Unlike the above-mentioned measures, the DES includes items that make reference to unusual experiences that can indicate psychological dysfunctions (e.g., looking in a mirror and not recognizing oneself; feeling that other people, objects, and the world around us are not real; etc.). Although we are not aware of studies that relate dissociation with driving errors, there is evidence that links dissociation to general measures of cognitive failures (Giesbrecht et al. 2008). Consequently, we considered that DES was worth including as a validation criterion for ARDES. In this case, we hypothesized that ARDES scores would correlate positively with DES subscales (absorption, amnesia, and depersonalization/derealization).

METHOD

Item and Scale Development

As a first step, we reviewed and selected items from the DBQ and MDSI scales. Some of the items were slightly modified so as to better measure the construct and could be applied to our research context. Additionally, the research team created new items, taking into account that they would have to indicate non-intentional errors in performance, resulting, in whole or in part, from attentional failures. We started with a 26-item pool, out of

which 4 were removed due to face validity problems (e.g., items related to absorption or daydreaming rather than to errors). Next, 3 items were removed based on feedback from peer reviewers (items that were not necessarily linked to driving; e.g., "I forget the exact place where I parked the car"). Thus, the final version of ARDES was a 19-item scale, which evinces attention-related errors, including (a) mistakes when monitoring traffic conditions, (b) unintentional deviations from a preset trip plan, and (c) action slips while driving. ARDES differs from DBQ and MDSI in that it includes expressions such as "for being inattentive" or "for not paying attention," which were added to several items to convey a more accurate attentional meaning to the statements. Another distinction from DBQ and MDSI scales consists of some ARDES items including the expression "unintentionally" to accurately transmit the unintended nature of the errors made. Emphasis on the unintended character of errors made is further stressed in ARDES initial instructions, which state: "The situations described below may happen unintentionally to people while driving their car."

A pilot test in which ARDES and several validation measures were administered suggested the need to modify these instruments. For instance, the need to change the format of some scale responses was identified. Both the DES and BPS turned out to be particularly problematic, because in the former, responses are given based on a percentage scale (0 to 100) and in the latter on a 7-point scale. Both formats are rather unusual in our context; therefore, the adoption of a 5-point Likert scale for the final study was agreed on. This format is more familiar and easier to answer for Argentine respondents.

Participants

A convenience sample of drivers was drawn from the general population of Mar del Plata, Argentina ($n = 301$). The following inclusion criteria were used: (a) must be at least 18 years of age, (b) must have a valid driver's license, and (c) must have reported driving at least once a week over the past 3 months. The age of the subjects ranged from 18 to 79 (mean = 38, $SD = 13.6$), 39 percent were in the 18- to 30-year-old age group, 46 percent in the 31- to 55-year-old age group, and 15 percent were above 55 years old. Women accounted for 48.8 percent of the sample. Most participants drove regularly (70.6% almost everyday; 20.4% some days of the week). On average, prior driving experience amounted to 18 years ($SD = 13.5$). Most participants (86%) had at least completed high school.

Variables and Measures

The Attention-Related Driving Errors Scale, which was specially constructed for this study, was used to assess driving attention-related errors. This scale comprises 19 items (see Table I) referring to nonintentional driving errors, resulting, in whole or in part, from attentional failures. Participants were asked to read each item and indicate on a 5-point scale the frequency with which the described situations happened to them, ranging from *never or almost never* (1) to *always or almost always* (5).

Table 1 Descriptive statistics for the 19-item Attention-Related Driving Errors Scale ($n = 301$)^a

Items ^b	Factor loading	Corrected item-total correlation	Mean	S.D.
When I head toward a known place, I drive past it for being inattentive	.45	.44	1.91	.95
I signal a move, and unintentionally make another (e.g., I turn on the right-turn blinker but turn left instead)	.59	.53	1.37	.74
On approaching an intersection, I miss a car coming down the road for being inattentive	.48	.44	1.56	.67
Suddenly I notice that I have lost or mistaken my way to a known place	.51	.50	1.44	.77
On approaching an intersection, instead of looking at the traffic coming in, I look at the opposite direction	.34	.33	1.77	.82
On approaching a corner, I don't realize that a pedestrian is crossing the street	.48	.43	1.28	.55
I don't realize that there is an object or a car behind and unintentionally hit into it	.49	.44	1.24	.52
I don't realize that the vehicle right in front of me has slowed down and I have to brake abruptly to avoid a crash	.62	.56	1.56	.73
Another driver honks at me making me realize that the traffic light has turned green	.44	.42	1.32	.58
I forget that my lights are on full beam until flashed by another motorist	.57	.50	1.52	.81
For a brief moment, I forget where I am heading to	.55	.53	1.40	.70
I have to take more turns than necessary to arrive at a place	.42	.42	1.92	.92
I drive through a traffic light that has just turned red as I was following the car right in front of me	.53	.47	1.95	.90
I try to drive the car forward and don't realize that I haven't put it into first gear	.44	.41	1.34	.66
I try to use a car device but use another one instead (e.g., I turn on the lights instead of the windshield wipers)	.47	.44	1.53	.77
I intend to go to a certain place and suddenly realize that I am heading somewhere else	.46	.45	1.34	.61
I realize that I had been inattentive and hadn't noticed the traffic light	.69	.62	1.47	.62
I unintentionally make a wrong turn or drive toward coming traffic	.61	.55	1.72	.76
I unintentionally make a mistake in shifting the gear or shift to the wrong gear	.49	.45	1.73	.78

^aExtraction method: ML; KMO = .87; Bartlett = 1649, $p < .001$.

^bOriginal items are written in Spanish.

Everyday life errors were assessed with the Attention-Related Cognitive Errors Scale (ARCES) and the Memory Failures Scale (MFS; Cheyne et al. 2006). The ARCES is a 12-item scale describing everyday performance failures arising directly or primarily from brief failures of sustained attention^c e.g., "I have absent-mindedly placed things in unintended locations (e.g., putting milk in the pantry or sugar in the fridge)." Cronbach's alpha for the sample in this study was .88. The MFS, in turn, includes 12 items tied to situations involving memory failures; e.g., "Even though I put things in a special place I still forget where they are" (Cronbach's alpha .86). ARCES and MFS employ a Likert scale of 5 possible responses ranging from *never* (1) to *very often* (5), with higher scores indicating a greater frequency of errors.

The Mindful-Attention Awareness Scale (MAAS; Brown and Ryan 2003) was used to assess general awareness and attention to present events and experiences. All items are negatively worded (e.g., "I find it difficult to stay focused on what's happening in the present") and were reversed for the analysis. In this study, MASS items were answered based on a 5-point scale, from *almost never* (1) to *almost always* (5). The Cronbach's alpha for the sample was .85.

Boredom proneness was measured with the BPS (Boredom Proneness Scale; Farmer and Sundberg 1986). Its 28 items (e.g., "Having to look at someone's home movies or travel slides bores me tremendously") were answered in this study on a 5-point basis, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). In this sample, an exploratory factor analysis (EFA) of BPS

yielded two factors corresponding to the Internal Stimulation (Cronbach's alpha .76) and External Stimulation (Cronbach's alpha .77) scales, respectively.

Dissociation was assessed with the Dissociative Experiences Scale (DES; Bernstein and Putnam 1986). This 28-item self-report instrument measures the frequency with which different types of dissociative experiences take place. In this study, items were answered on a 5-point scale ranging from *never or almost never* (1) to *always or almost always* (5). One item referring to driving was deleted from the analysis ("Some people have the experience of driving or riding in a car or bus or subway and suddenly realizing that they do not remember what has happened during all or part of the trip"). The Cronbach's alpha for the total scale in this sample was .87. An EFA revealed a three-factor scale: factor 1 was absorption/imaginative involvement (Cronbach's alpha .82); factor 2, dissociative amnesia and fugues (Cronbach's alpha .65); and factor 3, depersonalization/derealization experiences (Cronbach's alpha .71).

Finally, a brief structured questionnaire was used to measure sociodemographic and driving variables, including age, gender, level of education, type of driver's license, number of years driving, driving frequency, motor vehicle crashes, and traffic tickets for traffic violations over the past 2 years.

Procedure

Participants were directly and informally contacted by the research team and by a group of psychology student assistants. No financial compensation was offered for taking part in the

Table II Correlation matrix of variables in ARDES validation study^a

	ARDES	ARCES	MFS	MAAS	DES	DES.Abs	DES.Der	DES.Amn	BPS.Ext
ARCES	.73(**)								
MFS	.60(**)	.72(**)							
MAAS	-.52(**)	-.63(**)	-.73(**)						
DES	.56(**)	.56(**)	.58(**)	-.60(**)					
DES.Abs	.53(**)	.58(**)	.58(**)	-.58(**)	.92(**)				
DES.Der	.42(**)	.33(**)	.39(**)	-.44(**)	.85(**)	.66(**)			
DES.Amn	.52(**)	.45(**)	.50(**)	-.46(**)	.77(**)	.59(**)	.61(**)		
BPS.Ext	.23(**)	.19(**)	.30(**)	-.40(**)	.38(**)	.35(**)	.33(**)	.28(**)	
BPS.Int	.15(**)	.14(*)	.13(*)	.20(*)	.26(**)	.22(**)	.20(**)	.22(**)	.30(**)

^aARDES: Attention-Related Driving Errors Scale; ARCES: Attention-Related Cognitive Errors Scale; MFS: Memory Failures Scale; MAAS: Mindful-Attention Awareness Scale; DES: Dissociative Experiences Scale (total score); DES.Abs: DES Absorption subscale; DES.Der: DES Derealization subscale; DES.Amn: DES Amnesia subscale; BPS.E: Boredom Proneness Scale (External Stimulation); BPS.I: Boredom Proneness Scale (Internal Stimulation).

* $p < .05$ (unilateral), ** $p < .01$ (unilateral).

study. All participants who were briefed on the study's objectives and scope gave their verbal consent to participate. The response rate was very high (>95%). The ARDES and validation measures were administered jointly. The questionnaires were anonymously completed in an average time of 15 minutes. Data were managed and analyzed with SPSS 11.5 and ViSta 6.4. The following statistical analyses were performed: (a) EFA to assess ARDES scores dimensionality (extraction method: maximum likelihood; number of factor selection: parallel analysis); (b) classical item analysis and reliability analysis of ARDES scores; (c) analysis of covariance (ANCOVA) to examine differences in ARDES scores due to gender, level of education, age, and number of years driving; (d) logistic regression analysis to determine the association between ARDES and the presence of self-reported motor vehicle crashes and tickets for traffic violations, controlling for sociodemographic variables and the other general measures (ARCES, MFS, MAAS, DES, and BPS); and (e) a correlation analysis between ARDES and validation measures.

RESULTS

The factor analysis suggested a single factor that exceeded the parallel analysis criterion and accounted for 30 percent of the total variance. All 19 items had positive loadings on this factor, ranging from .34 to .69 (see Table I). Corrected item-total correlations ranged from moderate to high, indicating that the items feature good discrimination power. Moreover, the internal consistency of ARDES scores was high (Cronbach's alpha .86). Based on the results above, we assumed that the items are indicators of the same unobserved domain (unidimensionality). All items were averaged into a single score, with higher scores representing greater error propensity. ARDES scores had a mean of 1.55 (SD .40), and the frequency distribution was right-skewed.

No significant differences in ARDES scores resulted from sociodemographic variables (i.e., gender, level of education, driving frequency, age, and number of years driving) as detected by ANCOVA. With regard to traffic crashes and tickets, the logistic regression analysis revealed that traffic collisions with only material damage were positively associated with ARDES

(adjusted odds ratio [aOR] = 7.14; 95% confidence interval [CI] 1.21–42.15, $p < .05$). No significant effects were found for the other variables. Crashes with injuries were not linked to any of the variables studied, which can be attributed to the small number of events ($n = 9$). Lastly, tickets were only associated with ARDES (aOR = 4.13; 95% CI 1.15–14.88, $p < .05$) and gender (aOR = .45; 95% CI .21–.99, $p < .05$). Men reported receiving more tickets than women.

Finally, a Pearson's correlation analysis yielded a consistent pattern of association between ARDES and the validation measures (see the correlation matrix in Table II). Given the fact that the distribution of ARDES was positively skewed, the correlation analysis was also performed based on logarithmic transformation. We also computed the nonparametric Spearman's correlations. In both cases, the results obtained were essentially the same, and so we opted to report the more conventional Pearson's correlations.

CONCLUSION

Attentional failures constitute a major road safety issue. This explains why intensive research efforts have centered on estimating their prevalence and determining the human and environmental factors tied to them. In this respect, the assessment of individual differences concerning proneness to attention-related errors while driving is a matter of theoretical and practical interest. Nevertheless, little effort has been devoted to developing measurement instruments in this field. The aim of this study was to evaluate the psychometric properties of a novel self-report measure, the Attention-Related Driving Errors Scale.

Results suggest that the items on this instrument are multiple indicators of a unidimensional construct. All 19 items yielded high loadings on the first factor, good discrimination indexes, and high internal consistency. We believe that, as a whole, ARDES items evaluate a common factor related to individual differences regarding attention-related errors while driving. This is in line with previous research using similar instruments, which encountered an "inattention factor" that could be differentiated from other dimensions of driver behavior (e.g., J. T. Reason et al. 1990; Taubman-Ben-Ari et al. 2004).

Evidence of validity for ARDES score was also obtained based on correlations with other measures. As predicted, ARDES was strongly correlated with the two measures of cognitive errors in everyday life (Cheyne et al. 2006). The correlation pattern between error measures in daily life (ARCES and MFS) and the other measures was also found to mirror the correlation pattern between these two and ARDES. These findings support the hypothesis that driving-related errors reflect, to a large extent, a more general tendency to experience attentional failures in everyday life. The fact that no differences were noticed based on driving experience and frequency of driving led to the assumption that the specific variables related to the driver profile do not play a key role in inattention phenomena. Moreover, the strong correlation with MAAS strengthens the hypothesis that this type of error is closely linked to a general functioning, characterized by inattention and lack of awareness in everyday life. Despite the fact that the previous literature has suggested that a relationship exists between absent-mindedness and errors (Cheyne et al. 2006; Herndon 2008), to the best of our knowledge, no studies evidencing such a relationship have been published so far.

In this framework, and as hypothesized, ARDES correlated with BPS. Previous research indicates that this variable is associated with inattention errors in daily life (Cheyne et al. 2006), which is an intuitive assumption because it basically denotes certain difficulty in maintaining attention. Even though the relationship between BPS and ARDES is modest, this result is construed as validity evidence for ARDES, because BPS correlation with ARCES and MFS was also weak.

In accordance with our hypothesis, we found that ARDES was positively correlated with the Dissociative Experience Scale as well as with its three subscales: Absorption, Amnesia, and Depersonalization/Derealization (Bernstein and Putnam 1986), respectively. In view of the fact that DES scores can bear a psychopathological meaning that the other validation measures do not share, we believe that this result opens a line of theoretical interest for future research efforts. To date, little has been explored regarding the relationship between psychopathology and attentional failures while driving. Although it has been well established that dissociation is associated with cognitive errors (Giesbrecht et al. 2008), this would be the first study reporting the existence of a strong relationship with driving attention errors.

Further evidence of validity was provided by the ability of the scale to discriminate between drivers who reported having been involved in at least one traffic collision and participants who reported not having ever been part of one. The same applied to the traffic tickets analyzed. These results are in accordance with some previous studies. Taubman-Ben-Ari et al. (2004), for instance, claimed that the dissociative style is associated with car crash involvement. It should be highlighted that the general measures are not significantly related to traffic crashes and prior tickets. Therefore, ARDES provides a more accurate specific measure in this respect. We believe that the new evidence furnished by ARDES is relevant, because forecasts

of previous traffic collisions are always subject to a series of difficulties and biases (Hole 2007), such as the low reliability of self-reports and the difficulty of differentiating active from passive crashes.

Needless to say, the analysis of official records of traffic collisions would be more desirable and reliable than that of self-reports. Yet, this is not feasible in Argentina where there are no official records of this nature. It would also be important to count on prospective studies in the future, to better analyze the predictive value of ARDES scores in relation to traffic crashes.

As far as the sociodemographic variables are concerned, no relationship was detected between ARDES and gender, age, level of education, or any of the other variables analyzed. Using DBQ, some studies have shown that, whereas men are more prone to traffic violations, women are more inclined to lapses (J. T. Reason et al. 1990; Westerman and Haigney 2000). It has also been reported that lapses would increase with the driver's age (Aberg and Rimmo 1998; Westerman and Haigney 2000). Nevertheless, other studies have reported neither age (Parker et al. 1995; J. T. Reason et al. 1990) nor gender differences (Aberg and Rimmo 1998). In the case of MDSI, Taubman-Ben-Ari et al. (2004) stated that women scored higher than men in the dissociative driving style and that an inverse relationship existed between said style and age. In our case, no evidence relating age or gender to driving errors was detected. Notwithstanding the foregoing, the lack of age effect could also be interpreted as a sampling bias. Many of the items in the ARDES, for instance, could be related to cognitive impairment, which shows up, to a large degree, in age groups over 60. Yet only 3 percent of the drivers in our sample fell into this age category.

There are other limitations in this study that should not be overlooked. Firstly, ARDES is a self-report measure and it may be sensitive to social desirability bias. Its main weakness, though, lies in the absence of such bias control, as well as in the fact that we validated one self-report measure with another. As a consequence, further validation studies should be conducted applying other methodologies and sources of information, such as traffic records, driving simulations, or naturalistic methodologies like those employed in other studies (e.g., Klauer et al. 2006). Another form of validation worth considering could be concordance analysis between self-and-other reports, such as that by Taubman-Ben-Ari (2004) with MDSI. From this author's viewpoint, the use of partner reports to verify individual reports is a useful validation measure, as it provides complementary data to estimate self-perception accuracy. Apart from the above-mentioned limitations, it should also be noted that ARDES was developed and validated in specific social and driving conditions and, thus, new validation studies would be needed to apply it to other cultural and geographic contexts.

We believe that further theoretical work is necessary to clarify the meaning and scope of several concepts (e.g., inattention, attention lapses, mindlessness, etc.), as well as their mutual relationships and the extent of overlap of what is being measured. By doing so we could gain a better understanding of the

psychological correlates of driving error propensity. Further research efforts should also be devoted to ascertaining whether ARDES measures individual differences in driving inattention, regardless of the external distraction sources to which drivers may be exposed. Important issues not addressed in this study include whether drivers who frequently engage in secondary activities score higher than those who do so less often, and, on a related matter, whether the scale actually measures an internal trait of inattention-proneness. Future research should aim at improving the understanding of the relationship between internal and external sources of inattention.

In conclusion, the present study provides preliminary results on ARDES's validity and reliability to assess individual differences in propensity for attention-related driving errors. We suggest that this instrument could be useful when applied for scientific and assessment ends. In addition, it can promptly measure individual inattention differences, which could be applied to the study of the psychological correlates of these phenomena, by either a psychometric or experimental approach. ARDES could further be applied as an assessment instrument to detect risk groups or subjects with high error propensity. This would also assist in the development of inattention-centered interventions. In short, we believe that ARDES constitutes a simple and useful tool that has significant potential to advance the study of inattention as well as the development of interventions to reduce the consequences of driver inattention on road safety.

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