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Assessing dangerous driving behavior during driving inattention: Psychometric adaptation and validation of the Attention-Related Driving Errors Scale in China

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ABSTRACT

Driver inattention is a significant cause of motor vehicle collisions and incidents. The purpose of this study was to translate the Attention-Related Driving Error Scale (ARDES) into Chinese and to verify its reliability and validity. A total of 317 drivers completed the Chinese version of the ARDES, the Dula Dangerous Driving Index (DDDI), the Attention-Related Cognitive Errors Scale (ARCES) and the Mindful Attention Awareness Scale (MAAS) questionnaires. Specific sociodemographic variables and traffic violations were also measured. Psychometric results confirm that the ARDES-China has adequate psychometric properties (Cronbach's alpha = 0.88) to be a useful tool for evaluating proneness to attentional errors in the Chinese driving population. First, ARDES-China scores were positively correlated with both DDDI scores and number of accidents in the prior year; in addition, ARDES-China scores were a significant predictor of dangerous driving behavior as measured by DDDI. Second, we found that ARDES-China scores were strongly correlated with ARCES scores and negatively correlated with MAAS scores. Finally, different demographic groups exhibited significant differences in ARDES scores; in particular, ARDES scores varied with years of driving experience.

1. Introduction

Driver inattention is widely discussed in the literature. After a detailed analysis of definitions and taxonomies of the phrase "driver inattention," Regan et al. (2011) concluded that driver inattention can be defined as insufficient or no attention to activities critical for safe driving. Driver inattention occurs when, for example, a driver does not realize that the vehicle in front of him has slowed down; he then must brake abruptly to avoid a crash. Driving is a complex behavior that requires multiple tasks to be performed simultaneously. Driver inattention produces errors and can cause failures in performance while driving (Hole, 2007). Evidence is increasingly emerging that driver inattention is the primary cause of motor vehicle collisions and incidents (Dingus et al., 2006; Klauer et al., 2006). According to the most recent Chinese Road Traffic Accident Statistics (CRTAS, 2012), 4.727 million traffic accidents occurred in 2012. Inattentive behaviors by drivers (e.g., failure to yield the right of way to others, driving in the wrong direction) accounted for 89.31% of these accidents. Considering the extremely negative influence of driver inattention on driving safety and the special traffic environment in China (for example, streets are often filled with pedestrians and bicycles, and traffic signs are often perplexing in China; Zhang et al., 2006), there is an urgent need to develop an effective instrument to explore attention-related driving errors in China.

Driver inattention has an influence on driving safety. Previous studies have shown that inattention impairs driver performance and is a significant risk factor for crash involvement (Farmer et al., 2010; Klauer et al., 2006; Lemercier et al., 2014; Stutts et al., 2001). According to one study, inattention is involved in between 10% and 33% of all accidents in the United States (Ranney, 2008). Harbluk et al. (2002) investigated the impact of cognitive distraction on driver behavior in an on-road experiment. Drivers drove an 8 km city route while performing three different secondary tasks as distractors. The experiment found that inattentive drivers checked their mirrors less often, had reduced eye-scanning behavior, and tended to brake more abruptly and more strongly. Another study asked drivers to report their inattention while completing a driving

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task in a simulated driving environment. The results indicated that inattentive driving entails a failure to monitor the environment and a decrease in the standard deviation (SD) of speed (He et al., 2011). Many studies have shown a reduction in both lateral and longitudinal SD when drivers were in an inattentive state (Kubose et al., 2006; Reimer, 2009), and a reduction in lateral variation could be considered to reflect a decline in performance (Reimer, 2009). Previous studies measured inattention in a specific scenario in an on-road or simulated driving environment. However, inattention occurs more often in actual driving than in experimental situations. Therefore, instead of studying inattention in specific laboratory scenarios, the questionnaire provides an alternative method to measure inattention while driving.

The Attention-Related Driving Error Scale (ARDES) is a 19-item self-reported questionnaire developed by Ledesma et al. (2010) to assess individual differences in the tendency to make attentional errors in specific driving contexts (e.g., "On approaching a corner, I do not realize that a pedestrian is crossing the street"). The original ARDES was constructed based on the culture and language in Argentina. Its items specifically refer to non-deliberate errors in driving behavior resulting from an attentional failure, such as failing to notice a traffic light due to inattention (Ledesma et al., 2010). These items were taken from the lapses scale of the Driving Behavior Questionnaire (DBQ; Reason et al., 1990) and from the Multidimensional Driving Style Inventory (MDSI; Taubman-Ben-Ari et al., 2004). In the DBQ, some items do not clearly refer to attention-related errors; for example, the "I plan my route badly, so that I hit the traffic that I could have avoided" item refers to an error in trip planning rather than inattentive driving. In the MDSI, the same applies to the "I misjudge the speed of an oncoming vehicle when passing" item, which instead reflects an error related to a lack of expertise. In comparison with these questionnaires, the ARDES specifically includes items referring only to attention-related errors due to attentional failures while driving. In addition, the ARDES was also constructed to avoid overlapping with other psychological constructs (such as daydreaming, absorption, or dissociation). Furthermore, the internal consistency of the original Argentinean version of the ARDES has been reported to be higher (Cronbach's alpha = 0.86) than that of the attentional lapse subscale of the DBQ (Cronbach's alpha values ranged from 0.64 to 0.69). An exploratory factor analysis suggested that all 19 items belong to a single factor that accounted for 30% of the total variance in the proneness to attentional errors while driving (Ledesma et al., 2010). The ARDES has also been validated in Spain, and the resulting ARDES-Spain scores have exhibited good internal consistency (Cronbach's alpha = 0.88). A factor analysis suggested that a single factor accounted for 32.70% of the total variance in ARDES-Spain scores (Roca et al., 2013a,b). Overall, the Cronbach's alpha coefficient values and the factor structure of the ARDES-Spain and ARDES-Argentina demonstrated that these scales exhibit good validity and reliability; thus, the ARDES can be considered as a simple and useful measure of individual differences in attention-related driving errors. Lopez-Ramon et al. (2011) found that the drivers with higher ARDES scores exhibited a general slowness in performance and less endogenous preparation for high-priority warning signs (Lopez-Ramon et al., 2011). However, because language, culture, traffic regulations and driving habits vary across countries, Roca et al. (2013a,b) study suggested that future studies that adapt this questionnaire to other countries would help to expand the cross-cultural equivalence of the ARDES. To our knowledge, the ARDES has not previously been validated in China.

The relationships between the ARDES and a variety of cognitive and psychological variables have been analyzed to provide further evidence of the validity of this scale. First, Ledesma et al. (2010) found significant correlations between ARDES scores and a general tendency to make attentional errors in everyday life, as measured using the Attention-Related Cognitive Errors Scale (ARCES). Inattentive driving errors may not only arise from triggering events but can also be affected by a given psychological state. Individual differences in cognitive abilities, such as the ability to maintain attention, exist, and certain psychological traits can lead to greater error-proneness. Individuals who are prone to inattention in their daily lives may also be more likely to be inattentive while driving. Second, driving attention errors are related to individuals' levels of awareness in the performance of daily life activities. Some studies have suggested that absent-mindedness is related to attentional failures in daily life (Herndon, 2008; Wallace and Vodanovich, 2003; Walsh et al., 2009). Ledesma et al. (2010) found significant negative correlations between ARDES scores and a lack of awareness in everyday life (Mindful Attention Awareness Scale, MAAS).

Driver inattention is also dependent on many intrinsic factors. These intrinsic variables may include the driver's age and years of driving experience (Young et al., 2008). Studies that have examined the relationship between age and inattention have yielded inconsistent results. Some studies have shown that older drivers have a lower attentional error propensity than do younger drivers (Roca et al., 2013a,b; Roca et al., 2013b; Smallwood et al., 2004). However, other research failed to find a correlation between age and inattention (Einstein and McDaniel, 1997; Ledesma et al., 2010). The results of studies that have investigated the relationship between years of driving experience and inattention have also been inconsistent. Klauer et al. (2006) showed that drivers who had more years of driving experience were more often involved in inattention-related accidents and near-accidents. One explanation of this finding could be that as a result of experience, older drivers may require fewer attentional resources for vehicle control and may make more inattention errors (Triggs and Regan, 1998). Another study found that the numbers of inattentive errors did not vary with the years of driving experience (Ledesma et al., 2010).

The aims of the current study were as follows:

(1) To adapt the Argentinean and Spanish versions of the ARDES to the culture, language, traffic environment and regulations of China and thus to provide a Chinese version of the ARDES;
(2) To verify the criterion validity of the ARDES by examining the relationships between the ARDES, dangerous driving behavior (as measured by a self-reported questionnaire, the Dula Dangerous Driving Index, DDDI) and self-reported traffic accidents and violations;
(3) To further verify the relationship between the ARDES and experiences in daily life by investigating the relationships between the ARDES, the ARCES, and the MAAS; and
(4) To investigate the relationships between driver inattention and sociodemographic characteristics (e.g., age, driving years).

2. Methods

2.1. Participants

A total of 317 participants (215 males and 102 females) completed the questionnaire voluntarily and anonymously. The participants were recruited by a research company through interviewing individual drivers encountered in or around parking lots or residential areas. The ages of the participants ranged from 20 to 60 years (mean = 38.41, SD = 10.09); 24.61% of the participants were of age 20–30 years, 60.25% were of age 31–50 years, and 15.14% were of age 51 years or older. The subjects who had completed high school accounted for 84.22% of the study sample. All of the participants were licensed drivers with more than one