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The impact of personality on driving safety among Chinese high-speed railway drivers

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ABSTRACT

This study explored the impact of personality traits on driving safety in high-speed railway drivers. A sample of high-speed railway drivers in Beijing ($N = 214$) completed a questionnaire, including information on personality traits and background variables. The NEO Five Factor Inventory (NEO-FFI) was administered to characterize participants based on five personality traits: Neuroticism, Extraversion, Agreeableness, Openness to Experience, and Conscientiousness. The survey data were combined with naturalistic data of accident involvement and risky driving behavior in China. Poisson regression results show that drivers with high Conscientiousness and Extraversion caused fewer accidents. Higher Conscientiousness and lower Agreeableness were related to less frequent risky driving behavior. Education level and age negatively moderated the relation between certain personality traits and driving safety. The findings suggest that personality traits should be considered when selecting and training high-speed railway drivers.

1. Introduction

High-speed railway (HSR) services are flourishing all over the world due to their speed, as well as their punctuality and energy efficiency. Plans for constructing high-speed railways have been initiated in Europe, North America, Asia, and other parts of the world (Campos and Rus, 2009). Though serious accidents rarely occur with high-speed railways, such accidents could result in many deaths due to the high speed. Indeed, accidents such as the 1998 Eschede train disaster in Germany, 2011 Wenzhou train collision in China, and 2013 Santiago de Compostela derailment in Spain caused many deaths. Previous studies suggest that train accidents are not only related to conditions of the environment, facilities, and equipment but also to conditions of the drivers, including their psychological condition (Baysari et al., 2008; Reinach and Viale, 2006). Indeed, HSR drivers must concentrate on driving at high speeds despite being vulnerable to various family- and work-related stressors. Particularly in the face of emergency incidents, such as signaling system malfunctions, drivers' psychological condition may become a dominating factor that ensures driving safety. Drivers with suitable personalities will be able to overcome difficulties and achieve safe driving.

Previous studies have shown that individual personalities affect driving behavior (Clarke and Robertson, 2005; Taubman-Ben-Ari and Yehiel, 2012; Jornet-Gibert et al., 2013). For instance, scholars found that personality traits are associated with the risk of traffic accidents (Matthews et al., 1991; Iversen and Rundmo, 2002; Ulleberg and Rundmo, 2003) and driving behavior (Garrity and Demick, 2001). However, existing studies have focused predominantly on car drivers. What appears to be lacking in existing studies is an examination of the relation between personality and high-speed railway drivers' driving safety, which was the central purpose of this study.

We aimed to fulfill this purpose by studying driving safety of high-speed railway drivers in China. Owing to the huge demand for HSR, based on a large population and fast urbanization, the high-speed railway is rapidly growing in China. According to the National Railway Administration of China, the total length of the China high-speed railway network reached 11,028 kilometers by 2013, and the growth of this network has been fast (NRAC, 2014). China owned 46% of the world's total high-speed railway mileage in 2013, which makes China a valuable context for studying high-speed railway driving safety.

1.1. Personality and driving safety

There is a body of empirical evidence demonstrating the link between personality factors and accident involvement. The influence of personality on driving behavior has been consistently demonstrated by theoretical and empirical research, mostly in car

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driving contexts (Chen, 2009; Costa and McCrae, 1992; Sarma et al., 2013). Dahlen et al. (2012) proposed that personality traits could predict both driving behavior and accidents.

There are many different ways of assessing personalities of drivers. The most widely adopted approach in safety research is the NEO Personality Inventory, which contains five robust factors and is widely adopted as a taxonomy of personality traits. The five factors include Extraversion, Agreeableness, Conscientiousness, Neuroticism (or Emotional Stability), and Openness to Experience (Cellar et al., 1996; John, 1990; John and Srivastava, 1999; Schmitt and Ryan, 1993). Tupes and Christal (1992) first introduced this inventory to predict important components of individual personalities. Because then, the validity and reliability of the Inventory has been supported in many studies (Digman, 1990; Goldberg, 1999). Scholars have consistently found that the NEO five-factor personality framework provides an integrated overview of personality traits.

Existing literature in car driving safety has provided evidence on the relation between the Big Five factors and driving safety. Among the Big Five factors, Neuroticism has been positively correlated with risky driving and road accidents (Matthews et al., 1991), and aggressive driving and driving anger (Dahlen and White, 2006; Jovanović et al., 2011). Neuroticism is a strong cause of dissatisfaction, mental illness, and driving stress. Extraversion and some of its sub-dimensions have been positively associated with traffic accidents and traffic offending (Lajunen, 2001; Renner and Anderle, 2000; Verwey and Zaidel, 2000). Research on the relation between Openness to Experience and risky driving is unclear (Hubicka et al., 2010; Miles and Johnson, 2003); although some facets of Openness, such as imagination and literary were negatively related to accidents of fighter pilots (Lardent, 1991). Agreeableness was inversely correlated with traffic citations (Cellar et al., 2000) and aggressive driving (Benfield et al., 2007), although some studies have not confirmed this association (Arthur and Graziano, 1996; Miles and Johnson, 2003). Finally, Conscientiousness has been negatively correlated with risky driving and accident involvement (Arthur and Doverspike, 2001; Arthur and Graziano, 1996; Cellar et al., 2001; Hubicka et al., 2010).

1.2. Driving safety in high-speed railway context

Most studies on risky driving behavior are about car driving and have used the 24-item Risky Driving Behavior Scale (Iversen, 2004) or 28-item Dula Dangerous Driving Index (Dula and Ballard, 2003) to measure driving safety (e.g., Bachoo et al., 2013; Sarma et al., 2013). However, such subjective measures may distort the findings when studying driving safety of large public transportation vehicles because it is difficult for drivers to memorize the exact number of safety violations. Given access to accurate data in the Bureau, we ensured measurement accuracy by using objective records of over two hundred types of accidents and risky driving behavior.

Findings derived from drivers' self-report data may or may not differ from real-world driving behavior. Two streams of literature aim to overcome this limitation by using naturalistic driving data. The first stream involves using in-vehicle technologies, such as GPS, for monitoring driver behavior (e.g., Guo and Fang, 2013; Jonasson and Rootzén, 2014). However, such studies are usually conducted on a small scale, with small sample sizes (e.g., 10–100) and limited numbers of vehicles (e.g., 1–100). Such studies have limitations with regard to external validity compared to studies that randomly select participants from a large pool. The other stream of literature is quite traditional and focuses on relating crash data to individual traits. However, crash data typically have low sample mean values. In this study, we overcome the above shortcomings by observing a large set of driving behavior of real high-speed railway drivers. The data collection procedure involved observing the daily routine of a railway bureau with the aid of devices and streamlined inspection procedures, thus creating little intrusion into drivers' daily work while using objective measures to evaluate their driving safety.

Our aim was to examine how personality traits affect driving accidents and risky driving behaviors of Chinese high-speed railway drivers. Based on the literature and interviews with drivers, it was hypothesized that the personality traits of Agreeableness, Openness, and Conscientiousness would positively predict driving safety, while Neuroticism and Extraversion would be negatively related to driving safety.

2. Materials and methods

2.1. Participants and procedure

This research was part of a large project dedicated to improving current personnel selection standards in the high-speed railway industry. The data were collected from the Beijing Railway Bureau. The study was conducted with the approval of the university's ethics review board and the targeted institution. Both naturalistic observation and survey method approaches were implemented.

The sampling frame covers all the high-speed railway drivers in this Bureau. In May 2013, with the help of bureau managers, all 221 high-speed railway drivers in this Bureau completed the NEO Personality Inventory and a Demographic Data questionnaire during an internal regular training session. In both oral and written forms, we promised the participating drivers that their responses would be confidential, would be used solely for research purposes and would not influence their income and promotion. After completion, all 221 questionnaires were returned to the researchers in sealed envelopes to ensure confidentiality. When we found extensive missing responses on the questionnaire, we contacted the respective driver to fill in the blanks. The survey yielded a response rate of 100%. After deleting seven cases with 10% or more missing data from the personality scale, we obtained a final sample of 214 drivers. In the final sample, respondents' ages ranged from 34 to 44 ($M = 37.43$, $SD = 2.59$). All respondents were male and almost all of them were married. 67.8% had received education from junior colleges, while others had received technical secondary school education. Railway driving experience ranged from 7 to 25 years ($M = 12.86$, $SD = 3.42$).

The Bureau provided objective records on accidents and risky driving behavior. We obtained the data from May 2013 to May 2014 to derive values for the two driving safety variables. By measuring driving safety during a period of time that followed the point in time when drivers' personality traits were measured, a time lag is created to improve causal inference. Each objective variable aggregated values from a list of nearly one hundred items. Data for a subset of items were recorded using devices such as driving data recorders, alcohol detectors, in-room cameras, and on-site cameras. Unfavorable behavior, such as removing one's feet from the pedals for a long time, drinking alcohol, speeding, arriving at stations late, and not handing over driving duties to a peer driver on time, can be detected automatically or semi-automatically. Data on other items are recorded based on monthly inspections conducted by officers of the Bureau. Every driver was inspected with the same frequency, which ensured the objectivity of the inspection.

Finally, we matched the two data sources. A t-test examination showed that the final sample was not significantly different from the excluded cases on any of the demographic variables.

2.2. Procedure and instruments

2.2.1. NEO personality inventory

To assess personality, we used the Chinese version of the NEO-Five Factor Inventory (NEO-FFI), based on the Five Factor Model