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Conscientious personality and young drivers' crash risk

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Abstract

Introduction—Personality characteristics are associated with many risk behaviors. However, the relationship between personality traits, risky driving behavior, and crash risk is poorly understood. The purpose of this study was to examine the association between personality, risky driving behavior and crashes and near-crashes, using naturalistic driving research methods.

Method—Participants' driving exposure, kinematic risky driving (KRD), high-risk secondary task engagement, and the frequency of crashes and near-crashes (CNC) were assessed over the first 18 months of licensure using naturalistic driving methods. A personality survey (NEO-Five Factor Inventory) was administered at baseline. The association between personality characteristics, KRD rate, secondary task engagement rate and CNC rate was estimated using a linear regression model. Mediation analysis was conducted to examine if participants' KRD rate or secondary task engagement rate mediated the relationship between personality and CNC. Data were collected as part of the Naturalistic Teen Driving Study.

Results—Conscientiousness was marginally negatively associated with CNC (path c = −0.034, p = .09) and both potential mediators KRD (path a = −0.040, p = .09) and secondary task engagement while driving (path a = −0.053, p = .03). KRD, but not secondary task engagement,

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was found to mediate (path b = 0.376, p = .02) the relationship between conscientiousness and CNC (path c' = −0.025, p = .20).

Conclusions—Using objective measures of driving behavior and a widely used personality construct, these findings present a causal pathway through which personality and risky driving are associated with CNC. Specifically, more conscientious teenage drivers engaged in fewer risky driving maneuvers, suffered fewer CNC.

Practical Applications—Part of the variability in crash-risk observed among newly licensed teenage drivers can be explained by personality. Parents and driving instructors may take teenage drivers' personality into account when providing guidance, and establishing norms and expectations about driving.

Problem

Motor vehicle crashes are the leading cause of death and a leading cause of injury for teens in the United States (Centers for Disease Control and Prevention, 2014). Crash rates per mile driven for 16- to 19-year-olds are four times the rates for adult drivers (Insurance Institute for Highway Safety, 2014). While all teenage drivers are particularly vulnerable due to inexperience (Mayhew, Simpson, & Pak, 2003), there is considerable variability in the crash experience of individual teenage drivers (Guo & Fang, 2013). Personality characteristics are associated with many risk behaviors among adolescents and are the subject of enduring interest in driving research, as they are stable traits and could explain some of the individual differences in teenage driver's crash risk (Cooper, Wood, Orcutt, & Albino, 2003). However, due to conceptual and methodological limitations in the existing literature, the relationship between personality traits, risky driving behavior, and crashes is poorly understood.

Psychologists broadly define personality as a "unique pattern of enduring thoughts, feelings, and actions that characterize a person" (Bernstein & Nash, 2008). There is no standard measure of personality that is used across all studies, making comparisons across studies difficult, and potentially limiting the development of a coherent body of literature on the issue. Studies examining the association between personality and driving behavior have relied on self-reported measures of driving (Arthur & Doverspike, 2001; Dahlen & White, 2006; Garrity & Demick, 2001; Gulliver & Begg, 2007; Machin & Sankey, 2008; Nichols, Classen, McPeek, & Breiner, 2012). These studies have shown modest associations between driving behavior and personality characteristics. However, the absence of objective measures of driving behavior is a universal limitation of the existing literature. Further, few have attempted to examine the mechanism through which personality characteristics influence certain driving behaviors, and how these relate to crashes. The purpose of this study was to examine the association between personality, risky driving, and crashes and near-crashes (CNC), in a sample of newly licensed drivers, using objective driving data from the Naturalistic Teen Driving Study.

Method

Participants and Data Collection

The primary vehicles of newly-licensed teens were equipped with sensors and cameras within three weeks of licensure, and participants were instructed to drive as they normally would. Multiple driving behaviors were measured over the first 18 months of licensure.

Participants and selection criteria

The protocol for this study required the participation of newly-licensed teenage drivers and at least one of their parents. Recruitment was conducted in local newspaper and driving schools in southwestern Virginia, USA. Participants were initially screened in a telephone interview for eligibility using the following inclusion criteria: (a) being less than 17 years old; (b) being newly licensed to drive independently, defined as holding a provisional driver's license allowing independent driving for no more than three weeks; (c) having at least one parent willing and able to participate; (d) access to a vehicle expected to survive mechanically for at least 18 months; (e) residing within a one hour drive of the research center; and (f) holding liability insurance on the vehicle to be used in the study (required by state law). Participants were excluded during the prescreen telephone interview if they: (a) had a diagnosis of attention deficit disorder (ADD) or attention deficit hyperactivity disorder (ADHD); (b) had an identical twin (which would make it difficult to distinguish when coding the identity of the driver); (c) needed to enter restricted areas (i.e., that do not allow cameras for security reasons); and (d) had only access to a pick-up truck (due to lack of a concealed space to install the instrumentation).

Participant recruitment was stratified to have a similar number of male and female teenage drivers and participants sharing and not sharing a vehicle with their parents. A total of 315 individuals responded to recruitment efforts, of which 42 fulfilled the eligibility criteria and were enrolled in the study. The final teenage sample comprised 22 females and 20 males with an average age of 16.4 years (SD 0.3). Over half of the parent participants (53.3%) reported a household income of over $100,000 and 84.4% reported a parent education level of a bachelor degree. During the study period, average household income in Virginia was $61,406 (U.S.Census Bureau, 2013a), and the percentage of individuals reporting educational attainment of a bachelor degree or higher was 34.4% (U.S.Census Bureau, 2013b). Vehicle and survey data were collected from June 2006 to September 2008.

Consent and incentives

Two consent forms were required for the study: parental consent and teenagers' assent for their participation. Teenager assent was obtained separately from the parent to ensure their participation was voluntary, and free from parental coercion. Participants were provided $75 for each month of participation in the naturalistic part of the study up to 18 months, and $20 per hour for completing questionnaires. Each participant received a bonus of $450 for completing all aspects of the study. The protocol was reviewed and approved by the Virginia Tech Institutional Review Board for the Protection of Human Subjects.

Vehicle Data

Teenagers drove a vehicle equipped with a data acquisition system that received and stored continuous data from: accelerometers that measured longitudinal, lateral, and yaw inputs; vehicle network that collected speed, turn signals, brake, and throttle pedal usage; a global positioning system (GPS) that calculated vehicle position, and speed; and six cameras. Four cameras continuously monitored the driver's face, the dashboard, and areas reachable by the driver's hands, as well as the forward and rear roadway. Two cameras also provided snapshots of the interior cabin of the vehicle as well as the rear-seat pan to capture passenger presence, seatbelt use, and age of passengers. With participants' permission, data were downloaded periodically by swapping the hard drives in the computers installed in the trunks of the vehicles. Study participants did not observe the replacement of the hard drives. The data were extracted from the hard drives and analyzed. Trained coders viewed the camera snapshot data for each vehicle trip and recorded the identity of the driver, and the sex and relative age of each passenger.

Dependent Variable: Crashes and Near-crashes Rate (CNC)

Coders identified each CNC by viewing video footage of highly elevated gravitational-force events recorded by accelerometers. A crash was defined as contact with an object at any speed in which kinetic energy was measurably transferred or dissipated. Near-crashes were close calls that did not result in actual contact due to successful evasive maneuvers taken at the last moment (Guo, Klauer, Hankey, & Dingus, 2010; Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006). The CNC rate was calculated using CNC counts and dividing by the number of miles driven for each teenage driver.

Independent Variable: Personality Characteristics

The NEO-Five Factor Inventory (NEO-FFI) was administered to participants at baseline to assess personality. The NEO-FFI is a 60-item measure of five personality traits: openness, conscientiousness, extraversion, agreeableness, and neuroticism, with 12 items measuring each domain (Costa & McCrae, 1989). The scale has a five-option response format (strongly disagree, disagree, neutral [cannot decide], agree, or strongly agree) to statements such as "I like to have a lot of people around me." The NEO-FFI was analyzed according to the subscales corresponding to each of the five personality traits. The number of items, range, mean, standard deviations, and reliabilities of the personality inventory for the teenage driving sample are provided in Table 1.

Potential Mediators

Kinematic Risky Driving Rate (KRD)—Driver acceleration behavior (g-force events) was aggregated into an index as a composite variable of elevated gravitational-force (g-force) events. This was created by counting each event over the threshold set for each of the 5 individual measures: longitudinal deceleration/hard braking (> -0.45 g); longitudinal acceleration/rapid starts (≥ 0.35 g); hard left and hard right turns (≥ 0.50 g); and yaw ($\geq \pm 6$ degrees within 3 seconds). Yaw is the change between an initial turn and the correction. A composite variable was created by counting any event over the threshold set for each of the five individual measures. The Cronbach's alpha for the composite measure was 0.78

(Simons-Morton, Zhang, Jackson, & Albert, 2012). The KRD rate was calculated as the frequency of elevated g-force events divided by total miles driven. KRD rate was highly correlated with CNC rate (r = 0.60). In receiver operating curve analyses the area under the curve was 0.76, showing high predictive validity with CNC rates (Simons-Morton et al., 2012). Analyses were conducted using the counts of the elevated g-force, accounting for the number of miles driven by each teenage driver.

Secondary Task Engagement Rate: Driving video footage for each driver was randomly sampled and stratified according to the number of miles the vehicle had traveled. Analysts viewed the video footage of the randomly sampled periods and recorded participants' secondary task engagement while driving (secondary task engagement) during a 6-second period of each sample. The sample of secondary tasks was restricted to high-risk behaviors associated with CNC (Klauer et al., 2014) including: cell phone-related secondary tasks, reaching for objects, using the radio or the air conditioning system, engaging in vehicle operations such as adjusting the mirrors or windows, looking at roadside objects, eating, and drinking (non-alcoholic beverages). The secondary task engagement rate was calculated as the total amount of secondary task divided by total miles driven.

Analytical Method

Linear regression models using PROC GLM were fit using trip level event rates of CNC. CNC, KRD, and secondary tasks rates per 1,000 miles were log transformed to satisfy the normal distribution assumption. Given the relatively small sample size, we set significance at p = .10 in this study. All analyses were conducted in SAS 9.3.

Mediation analysis was conducted to examine if participants' KRD or secondary task engagement rate mediated the relationship between personality and CNC based on the causal steps approach (Baron & Kenny, 1986). Given an independent variable (X: each personality measure), a dependent variable (Y: CNC), and a potential mediator (M: either KRD or secondary tasks), M is considered a mediator if X significantly accounts for variability in M, X significantly accounts for variability in Y, M significantly accounts for variability in Y when controlling for X, and the effect of X on Y decreases substantially when M is entered simultaneously with X as a predictor of Y.

Results

Conscientiousness was marginally, negatively associated with both the KRD (path a = −0.040, p = .09) and secondary tasks (path a = −0.053, p =.03). As shown in Table 2 and Figure 1, KRD rate was found to mediate the association between conscientiousness and CNC rate. The coefficient of path c from conscientiousness to CNC rate reduced from −0.034 (path c, p = .09) to −0.025 (path c', p = .20) when path b (from KRD to CNC) was added.

Although conscientiousness was significantly associated with CNC rate (path c) and secondary task engagement rate (path a), a mediation effect of secondary task engagement on the association between conscientiousness and CNC was not observed. The coefficients for path c' did not decline and path b was not significant. The remaining personality

characteristics (openness, extraversion, agreeableness and neuroticism) were not significantly associated with KRD, secondary tasks or CNC rates.

Discussion

We examined the association between personality traits and CNC rates using an established measure of personality and an objective measure of high-risk driving behavior, KRD, in a sample of newly-licensed teenage drivers. We found that conscientious personality was negatively associated with the rate of KRD, and this relationship entirely mediated the effect of conscientiousness on CNC rate. The same association was not observed between secondary task engagement rate, personality and CNC rate. Though the overall strength of the associations was modest, a causal pathway from a conscientious to CNC rate through KRD rate was identified. This suggests that part of the variability in CNC rate observed among newly-licensed teenage drivers can be explained by personality.

This study represents one of the first applications of naturalistic driving research methods to study the association between personality and driving behavior. These findings support existing literature that conscientiousness is related to self-reported risky driving among adult drivers (Arthur & Doverspike, 2001; Dahlen & White, 2006), risky driving in a virtual environment (Schwebel, Severson, Ball, & Rizzo, 2006), and a meta-analysis that found low conscientiousness was associated with more crashes (Clarke & Robertson, 2005). While the results presented in this study are in the same direction as previous studies, the magnitude of the observed association is smaller. This may suggest that studies reliant on self-report assessments of driving behavior have overestimated the association between personality and risky driving. Another possibility is that the relationship between personality and risky driving is weaker among teenagers. Newly licensed drivers are a high-risk group largely due to inexperience (Mayhew et al., 2003); and this may outweigh the effects of personality in the first months of driving.

The model of personality and risky driving behaviors as interactive factors associated with crashes could be used to inform safety interventions. While personality traits are not easily modifiable, the behaviors associated with them can be taught and reinforced. For example, parents and driving instructors may emphasize a conscientious approach to driving when providing guidance, and establishing driving limits. Parents and instructors could then exercise more vigilance in setting boundaries and rules for newly licensed teens that do not demonstrate conscientious behavior in general and while driving.

Limitations

The study sample came from households with higher education levels and incomes above the state average, which limits the generalizability of the findings. While the measure of personality used in this study (NEO-FFI) has not been standardized on a population of teenagers, a previous study (Spence, Owens, & Goodyer, 2012) reported reliability scores for the NEO-FFI that are similar to those found in our study, providing some support that the variability in our sample was typical for the target population. Future studies may consider

using other measures to test personality traits such as Sensation Seeking (Zuckerman, Eyseneck, & Eysenck, 1978) or Cognitive Control (O'Brien & Gormley, 2013).

This study did not provide the context or mechanisms through which personality influences driving. For example, it is unknown whether conscientious young drivers engage in lower KRD under all circumstances or only certain conditions. It is also likely that some portion of elevated g-force events reflect inattentive driving, poor judgment, or inexperience that may not be related to volitional risky driving. Although the mediation analysis used in this study showed an association between conscientiousness, KRD, and CNC, several researchers have questioned the robustness of the test (Hayes, 2009; Zhao, Lynch, & Chen, 2010).

Conclusion

Using objective measures of driving behavior this study established an association between risky driving, conscientiousness, and CNC. These findings provide insight into the nature of the relationships between personality characteristics and crash risk, and add to the literature on personality and driving by presenting causal pathways through which personality and risky driving behaviors factors are associated with crashes.

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Highlights

- The relationship between personality, risky driving behavior and crashes/near-crashes was assessed
- Conscientiousness was negatively associated with risky driving and secondary task engagement
- Risky driving was found to mediate the relationship between conscientiousness and crashes/near-crashes

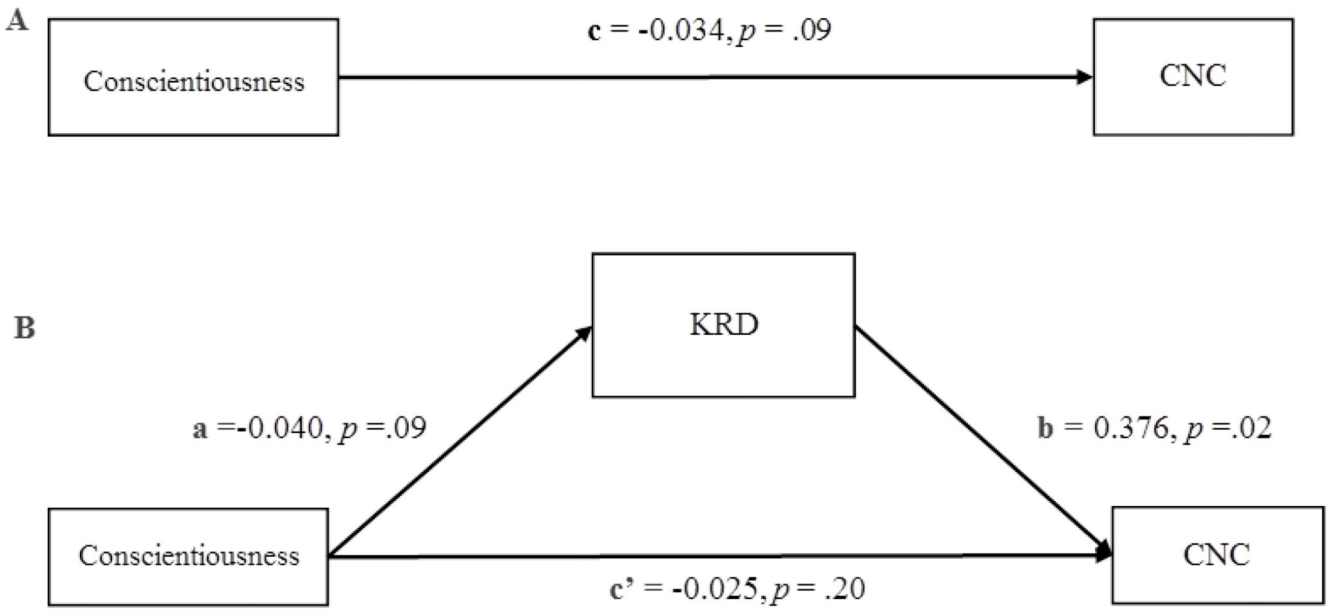

Figure 1.
Mediation effect of kinematic risky driving (KRD) on the relationship between conscientiousness and crashes/near-crashes (CNC). (A) Illustration of a direct effect. (B) Illustration of a mediation design.

Table 1

Personality variables: number of items, range, mean, standard deviations, and Cronbach's alphas.

	Teenagers				
Personality Scales	**# of items**	**Range**	**Median**	**Mean(SD)**	**Cronbach's alpha**
Openness	12	12 – 60	28	27.62(6.28)	0.74
Conscientiousness	12	12 – 60	30	29.78(6.51)	0.81
Extraversion	12	12 – 60	30	30.24(5.65)	0.74
Agreeableness	12	12 – 60	33	31.59(5.97)	0.84
Neuroticism	12	12 – 60	19.5	18.93(8.07)	0.88

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Table 2

Mediation effect of the kinematic risky driving rate (KRD) and the secondary task rate on the relationship between personality and the crashes and near-crash rate (CNC)

			Mediation pathway: KRD						Mediation pathway: Secondary tasks					
	Path c (Personality to CNC)		Path a (Personality to KRD)		Path c' (Personality to CNC w/ KRD)		Path b (KRD to CNC w/ personality)		Path a (Personality to secondary tasks)		Path c' (Personality to CNC w/ secondary tasks)		Path b (Secondary tasks to CNC w/ personality)	
	β	*p*	β	*p*	β	*p*	β	*p*	β	*p*	β	*p*	β	*p*
Openness	−0.005	.81	−0.008	.75	-	-	-	-	−0.027	.27	-	-	-	-
Conscientiousness	−0.034	.09	−0.040	.09	−0.025	.20	0.376	.02	−0.053	.03	−0.028	.21	0.107	.45
Extraversion	0.009	.72	0.006	.82	-	-	-	-	−0.023	.41	-	-	-	-
Agreeableness	−0.019	.42	−0.014	.60	-	-	-	-	−0.026	.33	-	-	-	-
Neuroticism	0.023	.17	0.020	.30	-	-	-	-	0.027	.16	-	-	-	-

Path c: bivariate association between each personality variable on CNC; Path a: bivariate between each personality variable and KRD/secondary task; path b: association between KRD and CNC controlling for each personality variable; path c': association between each personality variable on CNC controlling for KRD/secondary task.