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Co-variability in Three Dimensions of Teenage Driving Risk Behavior: Impaired Driving, Risky and Unsafe Driving Behavior, and Secondary Task Engagement

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Abstract

OBJECTIVE—This research examined the extent to which teenagers who engaged in one form of risky driving also engaged in other forms and if risky driving measures were reciprocally associated over time.

METHODS—The data were from waves 1, 2 and 3 (W1, W2 and W3) of the NEXT Generation study, with longitudinal assessment of a nationally representative sample starting with 10th graders starting in 2009–2010. Three measures of risky driving were assessed in autoregressive and cross-lagged analyses: driving while alcohol/drug impaired, Checkpoints Risky Driving Scale (risky and unsafe driving), and secondary task engagement while driving.

RESULTS—In adjusted auto-regression models the risk variables, demonstrated high levels of stability, with significant associations observed across the three waves. However, associations between variables were inconsistent. DWI at W2 was associated with risky and unsafe driving at W3 ($\beta = 0.21$, $p < 0.01$); risky and unsafe driving at W1 was associated with DWI at W2 ($\beta = 0.20$, $p < .01$); and risky and unsafe driving at W2 is associated with secondary task engagement at W3 ($\beta = 0.19$, $p < .01$). Overtime associations between DWI and secondary task engagement were not significant.

CONCLUSIONS—Our findings provide modest evidence for the co-variability of risky driving, with prospective associations between the Risky Driving Scale and the other measures,

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and reciprocal associations between all three variables at some time points. Secondary task engagement, however, appears largely to be an independent measure of risky driving. The findings suggest the importance of implementing interventions that addresses each of these driving risks.

Keywords

young drivers; teenagers; driving while alcohol/drug impaired; risk taking; alcohol; distraction

INTRODUCTION

Crash rates are higher among young drivers relative to experienced drivers (National Highway Traffic Safety Administration, 2013; Simons-Morton, Ouimet, Zhang, et al. 2011). While inexperience appears to account for at least some of the problem early in licensure, risky or dangerous driving in some form contributes to the problem throughout adolescence (National Highway Traffic Safety Administration, 2012; Simons-Morton et. al., 2011). Risky, dangerous, and unsafe driving can include driving under higher risk driving conditions, such as at night or in inclement weather; in a fast, aggressive, erratic, unsafe, or unlawful manner; engaging in distracting secondary tasks while driving; and impaired from alcohol or other drugs, a particular concern given that adolescent substance use, which is both illegal and dangerous in many ways, increases during adolescence (Johnston, O'Malley, Bachman, & Schulenberg, 2010), and the involvement of alcohol in a high proportion of fatal crashes among young drivers (National highway Traffic Safety Administration, 2012). Notably, most Graduated Driver Licensing (GDL) policies in the United States and other countries restrict driving to zero blood alcohol (Insurance Institute for Highway Safety http://www.iihs.org/iihs/topics/laws/graduatedlicense). These types or dimensions of risky driving may be related, one may precede the other or both may occur as a function of a risky behavior syndrome (Brener & Collins, 1998). For example, recent cross-sectional findings from national surveys of high school students indicated covariability in drinking and unsafe driving behaviors (Li, Simons-Morton, and Hingson, 2013; Terry-McElrath, O'Malley, and Johnston, 2014), consistent with research linking drinking in high school and later risky driving (Bingham and Shope, 2004; Zakrajsek and Shope, 2006). It is of continuing interest to examine possible prospective associations between measures of risky driving.

Unsafe driving can be due to driving conditions, such as inclement weather and late night, or volitional risks due driver behavior. Risky, dangerous, and unsafe driving behavior can be assessed through driving records, instrumented vehicle studies, and surveys. Crash databases, available through the Fatality Analysis Reporting System (National Highway Traffic Safety Administration, 2014a), National Automotive Sampling System (National Highway Traffic Safety Administration, 2014b), and from state departments of transportation and insurance companies, provide information about alcohol involvement and other driving conditions involved in crashes. Alcohol is involved in a disproportionately greater number of fatal crashes involving U.S. teenage drivers (National highway Traffic Safety Administration, 2012), compared to teenagers in other countries (Eurocare, 2003), in part because U.S. teenagers can get licensed at age 16. However, data on the prevalence of DWI, which cannot be determined accurately from crash data, is best obtained from survey research. Surveys can assess several dimensions of self-reported risky driving, including

DWI and unsafe driving behavior of the same individuals over time. Rates of DWI among high school students are high, with 10–20% reporting at least one event in the past month (Li, Simons-Morton, Brooks-Russell, et al., 2014; Terry-McElrath et. al., 2014).

Unsafe driving behavior has commonly been measured by self-report scales developed for this purpose, including the Driving Behavior Questionnaire (DBQ) (de Winter and Dodou, 2010), the Dula aggressive driving scale (Dula and Ballard, 2003), and the Checkpoints Risky Driving Scale (Simons-Morton, Li, et al., 2013). These scales include questions about speeding, tailgating, rolling through stops, etc. Research with young drivers has shown significant prospective associations between self-reported unsafe driving measures and negative driving outcomes, including objective measures of risky driving (Simons-Morton, et al., 2013), and violations and crashes (de Winter and Dodou, 2010).

Distraction due to secondary tasks has emerged as an important cause of motor vehicle crashes (Klauer, Guo, Simons-Morton, et al., 2014; Moreno, 2013; Simons-Morton, Guo, Klauer, et al., 2014). A recent naturalistic study found that a variety of secondary tasks were associated with crashes/near crashes among young drivers, including dialing, answering, and finding a hand held phone; texting; reaching for objects, and eating (Klauer et. al., 2014). Subsequent analyses of those data indicated that the length of time with eyes off the forward roadway during secondary task engagement was associated with crash/near crash risk, consistent with the contention that looking away from the forward roadway increases crash risk because the driver cannot identify and react to potential hazards (Simons-Morton et. al., 2014).

The NEXT Generation Study assessed self-reported DWI, risky and unsafe driving, and secondary task engagement in a national probability sample of high school students from 10–12th grade. The purpose of the current analyses is to evaluate reciprocal relationships across time between the three measures of risky and unsafe driving behaviors to determine if the measures co-vary over time.

METHODS

Sampling

The data used were from annual assessments at Waves 1, 2, and 3 (W1, W2 and W3) of the NEXT Generation Study, a longitudinal, nationally-representative study with a probability cohort recruited in the 10th grade students in the 2009–2010 school year. Sampling strategy has been reported elsewhere (Li et. al., 2014; Li et. al., 2013). In 10th grade, 2,525 (96.4%) of those from whom assent and parental consent had been obtained completed the survey at W1. At W2 additional schools were added, yielding 260 additional participants and a total of 2,423 of the 2879 (84.2%) recruited teenagers completed the survey at W2 and 2,408 (83.6%) at W3. The participants who had obtained an independent, unsupervised driving license by each wave were used for the analysis (n = 402 for W1, n = 880 for W2, and n = 1217 for W3). The study protocol was reviewed and approved by the Institutional Review Board of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development.

Measures

Measures were assessed annually at each wave.

Driving while alcohol/drug impaired (DWI) was measured using one question derived from the Youth Risk Behavior Survey (YRBS) questionnaire (Centers for Disease Control and Prevention, 2010) by asking participants on how many days in the last 30 days they drove after drinking alcohol or using illegal drugs. Due to severe floor effect and non-normal distribution of the data (the same reason for the dichotomous variables below), the DWI score was coded as a dichotomous variable: 1 = one day or more and 0 = no days.

Checkpoints Self-Reported Risky Driving Scale (C-RDS) was measured using 21 questions (Table 1) from the Checkpoints Self-Reported Risky Driving Scale (C-RDS) (Simons-Morton, Hartos, Leaf, et al. 2006) to measure unsafe driving behavior (e.g., on how many days in the last 30 days have you "…exceeded the speed limit in residential or school zones?" "…purposely tailgated or followed another vehicle very closely?"). In previous research C-RDS was highly correlated with the Dula Dangerous Driving Index (Dula and Ballard, 2003), and prospectively associated with kinematic risky driving, an objective measure of risky driving that assesses elevated gravitational force events due to hard braking, sharp turning, and over-correction (Simons-Morton, et al., 2013). In the current assessment the internal consistency of the C-RDS was good (Cronbach $\alpha = 0.90$). We dichotomized responses on each of the 21 questions (1 = at least 1 day vs. 0 = none) and summed the 21 dichotomies, with possible scores ranging from 0 to 21.

Secondary task engagement while driving (S-Task) was assessed on the basis of participants' responses to 9 questions (Table 1) (e.g., on how many days in the last 30 days had they "… received a call on your cell phone" or "…sent text messages" while driving?) (Simons-Morton et. al., 2006; Simons-Morton et. al., 2011). The internal consistency of the scale used to measure secondary task engagement while driving was good (Cronbach $\alpha = 0.87$). We then dichotomized the scores of the 9 questions (1= at least 1 day vs 0 = none) and summed the 9 dichotomies, with possible scores ranging from 0 to 9.

Potential Confounders

In analyses of the independent association between DWI and the other risky driving variables we controlled for heavy episodic drinking (Li et. al., 2014). *Heavy episodic drinking* was measured by asking teens, "Over the last 30 days, how many times (if any) have you had four (for females)/five (for males) or more drinks in a row on an occasion?" with response options from 1 = none to 6 = 10 or more times. The scores were dichotomized, 1 = at least once vs. 0 = none. The question was adapted from the Monitoring the Future national survey (Johnston, O'Malley, Bachman, and Schulenberg, 2010).

Demographic Variables

Participants reported age ($M = 16.19$ years/$SE = 0.04$ at W1), gender, race/ethnicity, family socioeconomic status, family structure, parent education, and days driven in the last 30 days. Family socioeconomic status was estimated using the Family Affluence Scale (Currie, Roberts, Morgan, Smith, Seyyertobulte, Samdal, and Rasmussen, 2004) and students were

then categorized as low, moderate and high affluence (Spriggs, Iannotti, Nansel, et al. 2007). Students were categorized as living with both biological parents, with one biological parent and one stepparent, single parent (mother only), single parent (father only), and others to indicate their family structure. Parents reported the education level of both parents and were categorized based on the highest level of education of either parent.

Statistical Analyses

Correlations (Pearson) between variables were calculated at each wave. Path analysis was used to examine the stability of individual differences from one wave to the next of DWI, C-RDS, and S-Task (autoregressive effect) and the effect of each construct on another measured at a later wave (cross-lagged effect) (Selig and Little, 2012). Features of complex survey design (i.e., stratification, clustering and longitudinal sampling weights) were taken into account. Probit regression coefficients (for the models with DWI included as binary outcome variable) and regression coefficients (for the models with C-RDS and S-Task as continuous outcome variables) were estimated with weighted least squares estimation (WLSMV) for the models with DWI included as binary outcomes. Regression coefficients were estimated with maximum likelihood parameter estimates with standard errors (MLR) for the models with C-RDS and S-Task as continuous variables.

Model fit was assessed using (a) the Chi square statistic, (b) Standardized Root Mean Square Residual (SRMR), (c) Root Mean Square Error of Approximation (RMSEA), (d) the Comparative Fit Index (CFI) and (e) the Tucker–Lewis index (TLI) (Li et. al., 2013; Weston, Gore, Chan, et al. 2008). The following thresholds were used to determine model fit: a non-significant chi-square; a SRMR value below 0.10, a RMSEA less than 0.06, and CFI and TLI values approaching 1.0.

The analyses were limited to those who had a license allowing independent, unsupervised driving at each wave. SAS (Version 9.3) was used to descriptive analysis and Mplus (Version 7.11) program was used for the model analysis.

RESULTS

Descriptive Analysis

Shown in Table 2 are the prevalence values for the study participants with independent, unsupervised driving licenses at W1 (402 of 2525 10^{th} graders), W2 (880 of 2432 11^{th} graders) and W3 (1217 of 2408 12th graders). Reported DWI in the past 30 day was 12.87% at W1, 12.53% at W2, and 14.31% at W3. Similarly, participants reported average risky driving behaviors in the past 30 days of 8.07 at W1, 7.39 at W2, and 8.15 at W3, and average number of secondary tasks in the past 30 days of 5.51 at W1, 5.32 at W2, and 5.51 at W3.

Bivariate Associations

Each of the risky driving measures was significantly correlated ($p < .001$) over time, with correlations $r \geq 0.40$ from W1 to W2 and W2 to W3 for C-RDS and S-Task, with somewhat lower correlations for DWI. Significant prospective correlations were observed across all

three waves for each pair of measures (Table 3). For example, the correlation between W1 DWI and C-RDS was r=0.42 at W1, r = 0.22 at W2 and r = 0.20 at W3; W1 DWI correlation with S-Task was r=0.31 at W1, r = 0.18 at W2 and r =0.21 at W3. W1 C-RDS correlation with S-Task was at W1 r=0.19, at W2 r = 0.47, and at W3 r = 0.40.

Autoregressive Cross-lagged Results

Cross-lagged panel models were specified via 7 steps: initial stability model without including confounders; initial stability model including potential confounders; initial stability model dropping non-significant (at p = .10 level) confounders; cross-lagged model including the paths from outcome 1 to outcome 2 (e.g., from C-RDS to DWI) only; cross-lagged model including the paths from outcome 2 to outcome 1 (e.g., from DWI to C-RDS) only; and cross-lagged model including the bidirectional paths between outcome 1 and outcome 2 (e.g., from C-RDS to DWI and from DWI to C-RDS) reciprocally. The final cross-lagged panel models were selected based on results of model fit indices and hypotheses specified to examine reciprocal relationships between DWI, and C-RDS and S-Task over three waves of data, adjusting for episodic drinking and selected demographic variables.

Overall, as showed in Figures 1 – 3, autoregressive associations are significant across the 3 waves for DWI, and C-RDS and S-Task, indicating the relatively high degree of stability over time for each risky driving behavior.

Figure 1 shows the autoregressive cross-lagged model for DWI and C-RDS. The cross-lagged associations from DWI at W2 to C-RDS W3 and from C-RDS at W1 to DWI at W2 are significant, providing evidence of reciprocal association.

Figure 2 shows the autoregressive cross-lagged model of DWI and S-Task. S-Task and DWI were not associated prospectively.

Figure 3 shows the autoregressive cross-lagged model of C-RDS and S-Task. The only significant cross-lagged association was found from C-RDS at W2 to S-Task at W3.

DISCUSSION

The NEXT Generation Longitudinal study provided a unique and important opportunity to examine the co-variability of three measures of risky driving, DWI, the Checkpoints Risky Driving Scale, and secondary task engagement. The findings indicate that each measure was stable over time, with significant and relatively-high positive correlations based on both correlation and autoregressive models. Similarly, we found prospective associations between the variables, particularly between the Risky Driving Scale and both DWI and secondary task engagement, but not between DWI and secondary task engagement. These findings are of interest to the extent that one measure of risk can be predicted by assessment of another measure of risk, or if it can be determined that there are common determinants of multiple risks that could then be addressed programmatically. Possibly, risky, dangerous, and unsafe driving in various forms is simply a reflection of the general propensity for risk, or possibly

engaging in one risky driving behavior normalizes other types of risky driving behavior, thereby increasing prevalence.

We found some reciprocal, over-time associations between DWI and Risky Driving Scale. Notably, W1 Risky Driving was associated with W2 DWI, and W2 DWI was associated with W3 Risky Driving Scale, while the W2 Risky Driving Scale was associated with W3 secondary task engagement. Because the analyses controlled for alcohol use as well as other selected covariates, the association between DWI and the Risk Driving Scale can be viewed as particularly strong. With respect to adolescents in our sample who had been driving for at least one year, our data for some time points are consistent with the contention that DWI and risky driving represent generalized measures of risk. Furthermore, those who engage in high levels of routine risky driving behavior may be more likely also engage in DWI, while those who engage in DWI appear more likely to also engage in routine risky driving behavior. Further research is needed to determine if these two measures of risky driving share common determinants, such as personality or social influence.

We found no evidence that secondary task engagement was prospectively associated with either DWI or risky driving. We conclude that secondary task engagement is an independent measure of risk. Given its high prevalence among teen and adult drivers, and the tendency of teenagers to begin driving with well-established patterns of smart phone use, secondary task engagement may be a unique risky driving behavior. Research is needed to determine if the predictors of secondary task engagement are similar to the risk factors for other risky driving behavior. In any case, with solid evidence showing that distraction due to secondary tasks is a primary cause of motor vehicle crashes (Klauer et. al., 2014; Moreno, 2013), specific programmatic and policy efforts are needed to curb secondary task engagement among young drivers.

This is one of few prospective studies to examine co-variation in risky and unsafe driving behavior. Strengths of the study include the national sample and the longitudinal assessment of three measures of risky driving, and cross-lagged autoregressive analyses adjusted for drinking. Previous research has shown that drinking alcohol is significantly associated with DWI, unsafe driving, and negative driving outcomes (Li et. al., 2013; Terry-McElrath et. al., 2014). Therefore, we controlled for drinking in the analyses to better evaluate the co-variability of the risky driving measures. Limits of the study include the relatively small samples of licensed study participants, particularly at W1, and the lack of objective measures of risk with which to compare or validate the self-report measures. Also, co-variability in this case indicates statistical association, but does not indicate that the behaviors were engaged in during the same drive, only over the same, recent period of time.

Conclusion

Our findings provide modest evidence for the co-variability of DWI and the Risky Driving Scale, with reciprocal associations at some, but not all, time points. The Checkpoints Risky Driving Scale was prospectively associated with secondary task engagement from 10^{th} to 11^{th} grade, but reciprocal associations between secondary task engagement and the other measures of risk were not significant. Secondary task engagement appears to be an independent measure of risky driving. Conversely, the association of risky driving with both

DWI and secondary task engagement provide evidence that measures of risky driving co-vary. Additional research is needed to identify common determinants of driving risk among teenagers. While it is possibly that interventions that effectively address one source of risky driving could also reduce other sources of risky driving, this has not yet been demonstrated and additional research is needed on the effects of GDL and other prevention measures.

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References

Bingham CR, Shope JT. Adolescent developmental antecedents of risky driving among young adults. J Stud Alcohol. 2004; 65(1):84–94. [PubMed: 15000507]

Brener ND, Collins JL. Co-occurrence of health-risk behaviors among adolescents in the United States. J Adolesc Health. 1998; 22:209–213. [PubMed: 9502008]

Centers for Disease Control and Prevention. Youth Risk Behavior Surveillance — United States, 2009. MMWR. 2010; 59(SS-5)

Currie, C.; Roberts, C.; Morgan, A.; Smith, R.; Seyyertobulte, W.; Samdal, O.; Rasmussen, VB. Health Behaviour in School-aged Children (HBSC) study: International report from the 2001/2002 survey. Copenhagen: WHO Regional Office for Europe; 2004. Young people's health in context.

de Winter JC, Dodou D. The Driver Behaviour Questionnaire as a predictor of accidents: a meta-analysis. J Saf Res. 2010; 41(6):463–470.

Dula CS, Ballard ME. Development and Evaluation of a Measure of Dangerous, Aggressive, Negative Emotional, and Risky Driving. J Appl Soc Psychol. 2003; 33(2):263–282.

Eurocare. Drinking and Driving In Europe. 2003. Downloaded from http://www.eurocare.org/resources/policy_issues/road_safety

Insurance Institute for Highway Safety. Downloaded from http://www.iihs.org/iihs/topics/laws/graduatedlicense

Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the future: National results on adolescent drug use. The National Institute on Drug Abuse National Institutes of Health; 2010.

Klauer SG, Guo F, Simons-Morton BG, Ouimet MC, Lee SE, Dingus TA. Distracted Driving and Risk of Road Crashes among Novice and Experienced Drivers. N Engl J Med. 2014; 370(1):54–59. [PubMed: 24382065]

Li K, Simons-Morton BG, Brooks-Russell A, Ehsani J, Hingson R. Drinking and parenting practices as predictors of impaired driving behaviors among U.S. adolescents. Journal of Studies on Alcohol and Drugs. 2014; 75(1):5–15. [PubMed: 24411792]

Li K, Simons-Morton BG, Hingson R. Impaired-Driving Prevalence Among US High School Students: Associations With Substance Use and Risky Driving Behaviors. Am J Public Health. 2013; 103(11):e71–e77. [PubMed: 24028236]

Moreno MA. Distracted driving and motor vehicle crashes among teens. JAMA Pediatr. 2013; 167(10):984. [PubMed: 24100395]

National Highway Traffic Safety Administration. Traffic safety facts 2011: Alcohol-impaired driving. 2012.

National Highway Traffic Safety Administration. 2012 Motor Vehicle Crashes: Overview. Washington (DC): NHTSA; 2013.

National Highway Traffic Safety Administration. National Automotive Sampling System (NASS). National highway Traffic Safety Administration. http://www.nhtsa.gov/NASS.5-9-2014a

National Highway Traffic Safety Administration (NHTSA). Fatality Analysis Reporting System (FARS). National highway Traffic Safety Administration. http://www.nhtsa.gov/FARS.5-9-2014b

Selig and Little. Autoregressive and cross-lagged panel analysis for longitudinal data. In: Laursen, B.; Little, TD.; Card, NA., editors. In book: Handbook of developmental research methods. 2012. p. 265-278.

Simons-Morton BG, Guo F, Klauer SG, Ehsani JP, Pradhan AK. Keep Your Eyes on the Road: Young Driver Crash Risk Increases According to Duration of Distraction. J Adolesc Health. 2014; 54(5, Supplement):S61–S67. [PubMed: 24759443]

Simons-Morton BG, Hartos L, Leaf WA, Preusser DF. The effect on teen driving outcomes of the Checkpoints Program in a state-wide trial. Accid Anal Prev. 2006; 38(5):907–912. [PubMed: 16620739]

Simons-Morton, BG.; Li, K–G.; Russell, A.; Ehsani, J.; Pradhan, A.; Ouimet, MC.; Klauer, S. Validity of the C-RDS self-reported risky driving measure. Proceedings of the 7th International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design; Iowa City, Iowa: The University of Iowa; 2013. p. 22-28.

Simons-Morton BG, Ouimet MC, Zhang Z, Klauer SE, Lee SE, Wang J, Albert PS, Dingus TA. Crash and Risky Driving Involvement Among Novice Adolescent Drivers and Their Parents. Am J Publ Health. 2011; 101(12):2362–2367.

Spriggs AL, Iannotti RJ, Nansel TR, Haynie DL. Adolescent bullying involvement and perceived family, peer and school relations: Commonalities and differences across race/ethnicity. J Adolesc Health. 2007; 41(3):283–293. [PubMed: 17707299]

Terry-McElrath YM, O'Malley PM, Johnston LD. Alcohol and marijuana use patterns associated with unsafe driving among u.s. High school seniors: high use frequency, concurrent use, and simultaneous use. J Stud Alcohol Drugs. 2014; 75(3):378–389. [PubMed: 24766749]

Weston R, Gore J, Chan F, Catalano D. An introduction to using structural equation models in rehabilitation psychology. Rehabil Psychol. 2008; 53(3):340–356.

Zakrajsek JS, Shope JT. Longitudinal examination of underage drinking and subsequent drinking and risky driving. J Saf Res. 2006; 37(5):443–451.

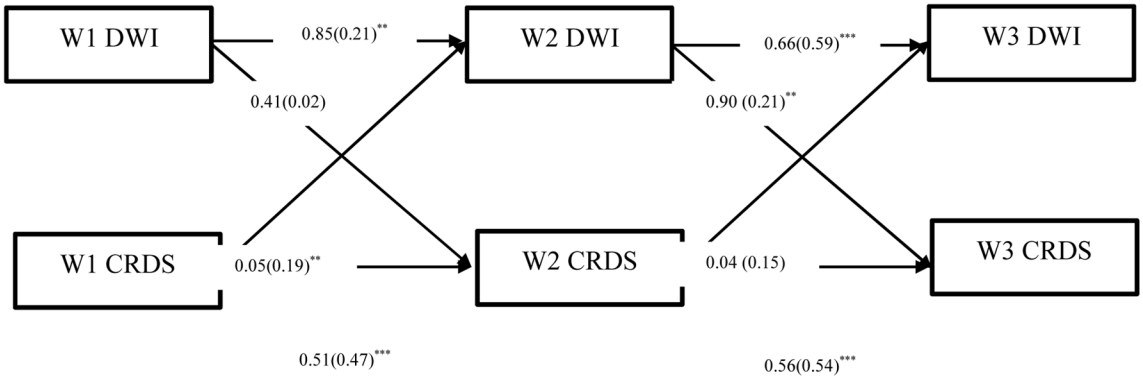

Fig. 1.

Autoregressive cross-lagged model of DWI and C-RDS.

RMSEA = <0.001; 90% CI: <.001, .019; Chi-square = 45.33, DF = 48, p =.58; CFI = 1.000; TLI = 1.000; path coefficients unstandardized and standardized (in the parentheses) probit regression coefficients. The model was adjusted for selected covariates.

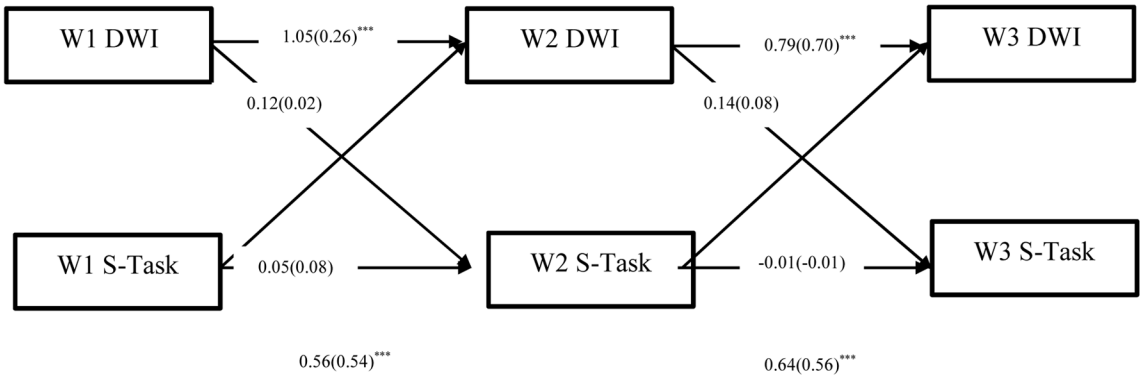

Fig. 2.

Autoregressive cross-lagged model of DWI and Secondary Tasks while driving RMSEA = 0.007; 90% CI: <.001, .022; Chi-square = 48.27, DF = 46, p =.38; CFI = .990; TLI = .977; path coefficients unstandardized and standardized (in the parentheses) probit regression coefficients. The model was adjusted for selected covariates.

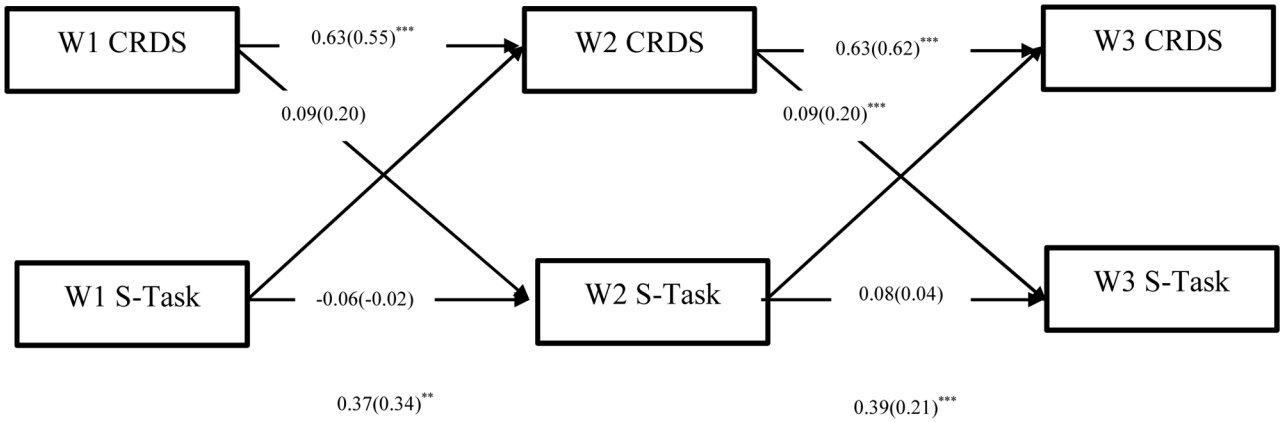

Fig. 3.

Autoregressive cross-lagged model of C-RDS and Secondary Tasks while driving RMSEA = 0.020; 90% CI: .002, .032; Chi-square = 53.523, DF = 38, p <.001; CFI = .984; TLI = .965; path coefficients are unstandardized and standardized (in the parentheses) regression coefficients. The model was adjusted for selected covariates.

Table 1

Questions used to measure Checkpoints Risky Driving Scale (C-RDS), and Secondary Task engagement while driving (S-Task)

	On how many days in the last 30 days have you done the following while driving?
C-RDS	• Exceeded the speed limit in residential or school zones?
	• Drove 10–19 miles per hour over the speed limit?
	• Drove 20 or more miles per hour over the speed limit?
	• Purposely tailgated or followed another vehicle very closely?
	• Switched lanes to weave through slower traffic?
	• Changed lanes with very little room between vehicles?
	• Cut in front of a vehicle to turn?
	• Pulled out into traffic without waiting for a large space between vehicles?
	• Made an illegal U-turn?
	• Went through an intersection when the light was yellow or just turning yellow?
	• Went through an intersection when the light was red or just turning red?
	• Went through a stop sign without stopping completely?
	• Changed lanes without signaling?
	• Played the radio?
	• Raced another vehicle, even just for a short distance?
	• Drove in a way to show off to other people?
	• Drove without wearing a seat belt?
	• Drove with 2 or more passengers about your age in the vehicle?
	• Drove when sleepy or drowsy?
	• Drove after midnight?
	• Drove in inclement weather (icy, snowy, or heavy rain)?
S-Task	• Made or answered a call?
	• Read or sent a text/message?
	• Read or sent an email?
	• Checked a website, or social network such as Twitter or Facebook?
	• Frequently changed music?
	• Used an iPad, tablet or computer?
	• Looked at directions, on a map, phone or navigation device?
	• Ate food or drank?
	• Looked in the mirror to fix hair or put on makeup?
	• Looked away from the road while reaching for something? (For example, phone, wallet, food, bag, etc.)
	• Goofed around with passengers?
	• Played music so loudly you wouldn’t be able to hear other vehicle horns or sirens?

Table 2

Percentage of DWI in the Past Month and Means of C-RDS and Secondary Task engagement while driving among 10th, 11th, and 12th-Grade Students: NEXT Generation Study, 2009–2012

School Grade/Year	DWI at Least 1 Day			C-RDS (score range: 0 – 21)			Secondary Task (score range: 0 – 9)		
	No.	Weighted % (SE)	95% CI	No.	Weighted Mean (SE)	95% CI	No.	Weighted Mean (SE)	95% CI
10th: 2009 – 2010	396	12.87 (3.57)	5.40, 20.33	398	8.07 (0.33)	7.39, 8.76	397	5.51 (0.14)	5.21, 5.80
11th: 2010 – 2011	844	12.53 (1.44)	9.53, 15.52	869	7.80 (0.19)	7.39, 8.20	875	5.32 (0.09)	5.14, 5.50
12th: 2011 – 2012	1208	14.31 (2.07)	9.98, 18.63	1213	8.15 (0.18)	7.78, 8.52	1216	5.51 (0.09)	5.31, 5.71

Note. DWI = driving while alcohol/drug impaired; There were 402, 880, and 1217 students who had independent driving license in waves 1, 2, and 3 respectively. The sample sizes in the analyses may not be equal to the total numbers above due to missing values.

Table 3

Correlation between C-RDS, Secondary Task, and DWI in three waves

	1	2	3	4	5	6	7	8	9
Wave 1									
1 DWI	-	0.42***	0.23***	0.31***	0.22***	0.18***	0.22***	0.20***	0.21***
2 C-RDS		-	0.72***	0.19***	0.50***	0.47***	0.26***	0.45***	0.40***
3 S-Task			-	0.15***	0.41***	0.48***	0.20***	0.35***	0.43***
Wave 2									
4 DWI				-	0.50***	0.28***	0.39***	0.29***	0.18***
5 C-RDS					-	0.68***	0.31***	0.53***	0.45***
6 S-Task						-	0.16***	0.40***	0.55***
Wave 3									
7 DWI							-	0.47***	0.28***
8 C-RDS								-	0.67***
9 S-Task									-

Note. Correlation was calculated using Pearson's correlation between two continuous variables, and one continuous and one dichotomous variable, and Spearman correlation between two dichotomous variables.