

# *Peer Effects on Driving*

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The Brain and Decision Making Laboratory  
Department of Psychology, University of Cincinnati  
Cincinnati, Ohio

C.-Y. Peter Chiu, PhD, Principal Investigator

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## ***Introduction***

In 2015 for which relevant statistics are available in the U.S. Midwest region, Motor vehicle accident (MVA) remains the leading cause of death for 18- to 21-year-olds, and is one of the leading causes of death among 22- to 25-year-olds (1). In the same year nationally, among drivers who were involved in fatal crashes, those who were 15 to 19 years old (9%) and 20 to 29 years old (8%) have the 2 largest proportions among all age groups of driving distracted in a variety of ways (2). While the effects of talking (3) and texting (4) on cell phones and other electronic device use on driving have been studied extensively in recent years, distraction can also occur as a result of driver-passenger interactions as well. More specifically, what aspects of the conversation between a driver and a passenger are more or less detrimental to driving remains poorly understood. In the current project using a driving simulator, we examined the effects of conversational dynamics between a driver and a peer passenger on driving performance as a function of driver age. Use of the driving simulator allowed us to observe how drivers react to dangerous conditions on the road without compromising their safety.

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## **Executive Summary**

This study explored the effects of conversational dynamics between the driver and a peer on driving performance on a driving simulator. Ohio drivers aged 18 to 40 with valid driver licenses were invited to come to the laboratory in pairs for a single 40-min drive session. Following informed consent procedure, one participant was randomly assigned to be the driver and the other the passenger. They were asked to carry out a natural conversation for the length of the drive, which lasted 45 minutes. Drivers were reminded to drive as they normally would (i.e., stay within speed limits, obey traffic laws and signals, avoid accidents as much as possible, etc.) without any additional requirements to meet time or distance goals. Following instructions and practice, the research assistant would leave the room, and both passenger and driver faced the monitor as the drive began. We measured number of collisions, average speed, lateral vehicle control (via lane position variability) and the brake-onset distance from red-light intersections as dependent variables. The results showed that younger drivers (18-19 years) had more variable lateral control over the vehicle compared to older (20-38 years) drivers. For younger, higher sensation-seeking participants, conversational synchrony was associated with greater lateral position variability. In addition, the less coordinated participants' conversations were, the greater the collision risk.

## **Qualifications of Project Personnel**

This study was led by two experimental psychologists, Drs. C.-Y. Peter Chiu and Kevin Shockley.

***Principal Investigator – C. - Y. Peter Chiu, PhD.*** Dr. Peter Chiu, Director of the Brain and Decision Making Laboratory at the University of Cincinnati, is an experimental psychologist and Associate Professor in the Depts. of Psychology and Communication Sciences and Disorders at the University of Cincinnati. For the past decade, he has studied how the brain works in young adults and adolescents in multiple domains, including risk taking, attention, inhibitory control, decision making and other areas of cognition using behavioral and brain imaging methods. His work has been supported by the National Institute of Health and the Air Force Office of Sponsored Research, and Ohio Department of Public Safety.

***Co-Principal Investigator – Kevin Shockley, PhD.*** Dr. Shockley is the Co-Director of the Center for the study of Cognition, Action, and Perception (CAP), Professor and Head of the Dept. of Psychology at University of Cincinnati. Dr. Shockley has been conducting research on movement dynamics since the late 1990s and is an internationally and nationally recognized expert in dynamical system analysis in human performance. He has published extensively on the quantification and measurements of dynamics of human performance for the past 2 decades.

***Project Managers – Patrick Nalepka, M.A., and Lynley Turkelson, BA.*** Mr. Nalepka and Ms. Turkelson are current senior and junior graduate students in the Dept. of Psychology at the

University of Cincinnati, respectively. Mr. Nalepka has extensive experience in conducting behavioral research, project management and data analyses and was involved in a previous, Ohio ODPS funded, project on driving, with responsibilities in programming a similar driving simulator at Cincinnati Children's Hospital Medical Center and data collection. Ms. Turkelson has experience in participant recruitment, data collection and various aspects of project management.

### **Literature Review, Background & Current Status of topic in Ohio and Nationally**

For 15- to 24-year olds, the most common cause of death at the national level in 2015 is motor vehicle crashes (1): about 1900 young (15- to 20-year-old) drivers died in MVAs, and an additional 195,000 such drivers were involved in crashes involving fatalities, both numbers representing an increase from 2014 (5). Driver distraction has long been recognized as a potential cause of motor vehicle accidents, especially for drivers younger than 20 and older than 70 years of age (see 6 for a review). Conversation with passengers has been estimated to occur in about 15% of total driving time (7,8), and this kind of distraction has been reported to be the cause of distraction for roughly 20% of cases where driver-reported distraction led to crashes serious enough where one vehicle needed to be towed (8). A major focus of recent research on distracted driving is on the use of cell phone (see 9 for an extensive review of over a hundred studies) and other hand-held devices, with relatively less attention paid to live

conversational interactions between drivers and passengers. Thus, the antecedent conditions and context of driver-passenger conversational interaction (e.g., type of conversations, conversational cohesions) associated with increased unsafe behaviors of young drivers remain to be better understood, and such understanding remains to be an extremely important part of all injury prevention efforts.

Previous research reports have documented an association between the number of passengers carried in the vehicle and injuries and death. For example, risk of death of drivers 16 years of age increases from 1.4 per million to 1.9 per million to 2.8 per million as number of passengers carried increased from 1, to 2, to 3 or more (e.g., 10). Tefft and colleagues (11) reported that relative to 0 passengers, the risk of being killed increased for 16- or 17-year old drivers by 44% (1 peer), 100% (2 peers), and 300% (3 or more peers) respectively when the passengers carried were younger than 21 years of age; conversely, having at least 1 passenger aged 35 or older decreased such risks by roughly 40%. These numbers provide strong support to the formulation of the current graduated driving law, which stipulates that drivers with probationary driver's license are not allowed to operate vehicles with more than 1 passenger unless such passengers included the license holder's parent, legal guardian or custodian (Ohio Revised Code 4507.071.B.4). Such passenger limits, however, are strictly age-based and independent of the nature and extent of previous driving experience of the license holders; the limits also do not extend to cover drivers older than 18 but under 21 years of age (for whom it

is reasonable to assume that the driving risk due to passenger-based distraction will be relatively comparable to those at age 16 and 17). In addition and more importantly, the risk statistics cited above do not reveal, by themselves, what specific contextual factors having young peers in the car pose to young drivers.

Teenagers who score higher on a scale measuring sensation seeking (e.g., experiment with risky behaviors; seek experiences that are thrilling) report an increase in risky driving behaviors such as speeding, racing another car, or passing in a no-pass zone (12). Cestac and colleagues (13) found that, within a sample of young drivers, sensation-seeking was most strongly related to the intent to speed intentions in novice drivers. Already, young drivers aged 16-24 are much more likely than older drivers to use cell phones (i.e., engage in interactions) while driving (14, 15). If the peer interactions in-vehicle also specifically implicitly or explicitly encouraged thrill or risk seeking, a further increase in risky driving behaviors may result. In a remarkable pair of studies, Simons-Morton and colleagues (16) reported an increase in risky driving behaviors of 16-18 year-old boys when they drove in a simulator in the presence of a peer confederate whom they perceived to be more risk-accepting (relative to the presence of a more risk-averse confederate). The visual scanning of drivers narrowed more both horizontally and vertically in the presence of the risk-accepting peer than the risk-averse peer (17). These findings are of interest because in both studies the male participants and the confederate did not know each other before the study and were not friends, nor have they interacted (the male

teenage subjects drove silently without talking to the confederate) except during a pre-drive priming phase. Even in this highly constrained scenario, risky driving behaviors increased as a result of peer acceptance.

In the context of young drivers, however, it seems equally clear that not all passenger-driver interactions are alike, and that some young drivers may be more likely to exhibit risky driving behaviors in the presence of some types of passengers amidst some types of interactions. Recent research on dynamical systems demonstrates that control of different parts of the body of an individual may exhibit coordination, and this characteristic could in turn affect cognition or behaviors: for example, listeners from speaker-listener pairs with higher coherence in eye movements were better able to recall their conversations (18).

In the present study, we observed on a driving simulator how young Ohio drivers handled driving in the presence of a peer passengers while they carry out conversations in naturalistic conditions. We made audio recordings of their conversations and analyzed the timing patterns of their conversational speech, specifically the onset and offset of their utterances. We then tested to see if conversational metrics derived from these timing patterns were related to their driving performance.

## **Data Issues and Considerations**

Our project design targeted those eligible participants who lived close to University of Cincinnati campus who could visit our laboratory during business hours at their convenience. Recruitment of eligible drivers was much more challenging than expected (particularly in December to February, 2015 & 2016), perhaps due to an improving economic climate and job availability. In addition, we observed a general decrease in the number of individuals attending college who have valid driver licenses, especially for freshmen and others who are more likely to live in dormitories. As a result, we broadened our original age goal (18-25) to a wider group (18-40) to increase participant recruitment.

## **Summary and Analysis of Findings**

**Method.** All drivers were tested in the same driving scenario (modeled after 19), which occurred on a two-lane highway, on a Systems Technology, Inc., STISIM Model 400 simulator, version 2.08.10, equipped with a 38" NEC XM3760 monitor. The simulation was displayed via a 42" Westinghouse LCD flat screen television. A Logitech MOMO Racing Force Feedback Wheel was used to evoke realistic driving feedback via gas and brake pedals and an adjustable car seat. In addition, the steering component provided up to 360 degree steering with speed sensitive "steering feel" provided by a computer controlled torque motor. Figure 1 illustrates the experimental setup.



Figure 1. Experimental setup using a System Technologies, Inc., STISIM Drive, build 2.08.10, a Westinghouse 42-inch LCD monitor and Logitech MOMO racing force feedback wheel.

The drive consisted of occasional oncoming traffic, pedestrian crossings and intersections with signal lights, a proportion of which transitioned from green-to-red. The environment transitioned from rural (small town) to city (urban) driving approximately every 5 minutes. During the course of a 45 min drive, driver participants were exposed to a series of challenging encounters with other road users, forcing them to brake and/or maneuver frequently. Participants were instructed to refrain from making any gratuitous stops and were also asked not to turn down any side streets. Drivers were also told to drive “as they normally would,” as well as adhere to the speed limit signs ranging from rural scenery speed (50 minimum, 60 maximum) and city driving (40 minimum, 50 maximum), as well as stop signs and red lights.

Each experimental session began with informed consent procedure, questionnaire responses, a 5-min practice drive, and finally the experimental drive immediately following the practice drive. Variables of interest during the driving portion included a) number of collisions, b) average speed, c) lateral vehicle control (operationalized as average variability of lane position) and d) the distance from intersections before which participants depressed the brake on a signal light change to red.

To assess conversational synchrony, conversations were recorded and later hand-coded at a sample of 1 Hz to detect instances of verbal utterances. Categorical cross-recurrence analysis was conducted to determine the value of %Recurrence, a nonlinear measure assessing the degree to which pairs' conversations were coordinated. Participants also completed a sensation-seeking questionnaire (AISS) before taking part of the driving study.

***Results on Driving Performance as a function of Demographics and Sensation-Seeking Behavior.***

A total of 54 pairs were included in analyses. A median split on age of driver (*Median* = 20 years) and median split on the AISS measure (*Median* = 47) was conducted. A resultant 17 pairs were placed in the Young-Age/Low-AISS group, 11 pairs in the Young-Age/High-AISS group, 15 pairs in the Old-Age/Low-AISS group, and 11 pairs in the Old-Age/High-AISS group. Table 1 presents summary results for the four subgroups on the three dependent measures considered related to driving performance. Age × AISS

between-subjects ANOVAs were conducted. A significant difference of lateral vehicle control across age groups was found,  $F(1,50) = 4.89$ ,  $p = .03$ , such that younger drivers had poorer lateral vehicle control compared to older drivers. A significant difference on distance away from intersection before brake onset was also found,  $F(1,50) = 4.49$ ,  $p = .04$ , such that younger drivers began braking further from the intersection than older drivers.

Table 1. *Mean rates of crashing and variability of lane position as a function of age and sensation-seeking scores. Standard deviations are in parenthesis. Groups are formed by median splits.*

Driver Behaviors	Age	High AISS	Low AISS
Number of Collisions	Younger (18-19)	2.45 (1.37)	2.82 (2.32)
	Older (20-38)	2.72 (2.00)	1.93 (1.67)
Average Speed (mph)	Younger (18-19)	53.65 (5.41)	54.11 (5.25)
	Older (20-38)	49.60 (5.11)	54.04 (3.63)
Lane Position Variability (feet)	Younger (18-19)	1.20 (.41)	1.19 (.25)
	Older (20-38)	.98 (.18)	1.08 (.25)
Distance from Intersection before Brake Onset (feet)	Younger (18-19)	387.93 (75.57)	330.30 (72.16)
	Older (20-38)	317.96 (59.80)	321.38 (59.46)

### ***Results on Relationship between measures of conversational dynamics and driving.***

A total of 26 pairs had conversations coded for analyses (6 Young-Age/Low-AISS pairs, 5 Young-Age/High-AISS pairs, 7 Old-Age/Low-AISS group, and 8 pairs in the Old-Age/High-AISS group). No

difference on conversational synchrony between age or AISS groups were detected. Pearson's correlations were conducted on conversational synchrony with collisions, average speed, average lane position variability and distance from red-light intersection before brake depression. These correlations were split between both between-subject conditions (Age and AISS groups). Table 2 provides a summary of the correlation results, highlighting correlations that were found significant.

Table 2. *Correlations between conversation synchrony with driving outcome measures, split between groups. Highlighted values indicate significant correlations ( $p < .05$ ).*

Driver Behaviors	Age	High AISS	Low AISS
Number of Collisions	Younger (18-19)	<b><math>r(3) = -.98, p &lt; .01</math></b>	<b><math>r(4) = -.82, p = .05</math></b>
	Older (20-38)	$r(6) = -.06, p = .895$	$r(5) = -.47, p = .29$
Average Speed (mph)	Younger (18-19)	$r(3) = .81, p = .1$	$r(4) = -.13, p = .81$
	Older (20-38)	$r(6) = .69, p = .06$	$r(5) = -.45, p = .31$
Lane Position Variability (feet)	Younger (18-19)	<b><math>r(3) = .97, p &lt; .01</math></b>	$r(4) = .52, p = .30$
	Older (20-38)	$r(6) = .41, p = .32$	$r(5) = .17, p = .71$
Distance from Intersection before Brake Onset (feet)	Younger (18-19)	$r(3) = -.17, p = .78$	$r(4) = -.57, p = .3$
	Older (20-38)	$r(6) = -.51, p = .20$	$r(5) = -.003, p = .995$

**Study Limitations.** It is important to bear in mind that the current findings are specific to the driving scenario we chose. As such, the drive was titrated so that drivers were unlikely to be

accident-free, but they were not likely to make an inordinate number of crashes. After each collision, the car and drive would restart.

## **Conclusions and Recommendations**

The key findings of the present study, within the context of the simulated driving conditions, can be summarized as follows:

1. Younger drivers (18-19 years) had more variable lateral control over the vehicle compared to older (20-38 years) drivers. For younger, higher sensation-seeking participants, conversational synchrony was associated with greater lateral position variability.
2. Number of collisions incurred by younger drivers was negatively associated with conversational synchrony. Less coordinated conversation led to greater collisions (and vice versa).

Compared to older drivers, younger drivers are still developing skills to maintain lateral control of a moving vehicle. The negative association between conversational synchrony and collision risk for young drivers indicates that conversing with a passenger in the car affects driving performance, while it appears to have no effect in older drivers. This suggests uncoordinated or more disjointed conversations may lead to collision risk for younger drivers as

drivers may be distracted away from the road in order to attend to the conversation. The present findings support recommendations to limit the number of passengers in the vehicle for younger drivers. Further, sampling in-cabin conversations at 1 Hz gives enough information for measures to assess differences in conversational synchrony and collision-risk. This may allow for future development of technological systems that can alert or take over control from younger drivers when the system detects disjointed/uncoordinated conversation that may lead to more distracted driving.

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