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Original article

Peer Passenger Influences on Male Adolescent Drivers' Visual Scanning Behavior During Simulated Driving

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A B S T R A C T

Purpose: There is a higher likelihood of crashes and fatalities when an adolescent drives with peer passengers, especially for male drivers and male passengers. Simulated driving of male adolescent drivers with male peer passengers was studied to examine passenger influences on distraction and inattention.
Methods: Male adolescents drove in a high-fidelity driving simulator with a male confederate who posed either as a risk-accepting passenger or as a risk-averse passenger. Drivers' eye movements were recorded. The visual scanning behavior of the drivers was compared when driving alone with when driving with a passenger and when driving with a risk-accepting passenger with a risk-averse passenger.
Results: The visual scanning of a driver significantly narrowed horizontally and vertically when driving with a peer passenger. There were no significant differences in the times the drivers' eyes were off the forward roadway when driving with a passenger versus when driving alone. Some significant correlations were found between personality characteristics and the outcome measures.
Conclusions: The presence of a male peer passenger was associated with a reduction in the visual scanning range of male adolescent drivers. This reduction could be a result of potential cognitive load imposed on the driver due to the presence of a passenger and the real or perceived normative influences or expectations from the passenger.

IMPLICATIONS AND CONTRIBUTION

The presence of male peer passengers was associated with deficient visual scanning in male adolescent drivers. Such reduced scanning behavior is evident in drivers with high cognitive load. Further investigation of passenger influences on adolescent drivers should include examination of distraction and inattention aspects of passenger influence.

Motor vehicle crashes (MVCs) are the leading cause of death and a major cause of injury among adolescents in the United States [1], with teenaged drivers having inordinately higher crash rates than other drivers [2]. These high crash rates have been attributed to a variety of factors including inexperience, immaturity, risk taking, and distraction [3,4]. Studies also identify the presence of peer passengers as an important risk factor for adolescent drivers' MVC, especially for male drivers with male peer passengers [5,6]; however, it is unclear what the mechanisms for these associations could be. Peer passengers could influence adolescent drivers by introducing visual distractions or by causing inattention to the driver due to other sources of influence such as social norms. The normative influence on adolescents from peers is well studied with peer pressure and influence on adolescents being stronger from risk-taking friends [7–10]. Thus the magnitude or direction of the passenger's influence could depend on the risk-taking propensity of the passenger or the driver's perception thereof.

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A few experimental studies have looked at the effects of peers on risky driving behaviors including a pilot study [11] that shows mixed results for risky driving with peer passengers. However, there is evidence that overt peer pressure results in risky behaviors as measured by other driving-related outcomes [12]. A separate article based on this current study [13] examining the effects of peer influence in the form of injunctive norms on risk-taking behaviors has found that adolescents are more likely to engage in risky behaviors in the presence of a passenger and in the presence of a risk-accepting passenger versus a risk-averse one.

However, there is limited research on passengers' influences on drivers' visual scanning. Drivers have different visual search patterns depending on factors such as age, experience, and cognitive load. Young and inexperienced drivers have different general scanning strategies and also look at different areas when driving. Young novice drivers scan less widely, look closer to the vehicle's front and right, look less often at mirrors, and tend to look at traffic-related objects for longer times than older and more experienced drivers [14]. As novices, young drivers have an underdeveloped scanning pattern while driving [14] and a tendency toward longer off-road glances [15]. In addition, less cognitively loaded drivers have wider search patterns compared with more cognitively loaded drivers [16–19]. Wide visual scanning is an important component of safe driving [20], and narrow scanning patterns increase probabilities of missing signs, lessen abilities to anticipate risky driving situations, and increase likelihood of failing to detect hazards. Other aspects of teen driving, including driving with passengers, may further adversely affect adolescents' scanning behavior, especially if the driver's visual attention is shifted away from the forward roadway and toward vehicle occupants. In this study, we are interested in understanding the influence of peer passengers on adolescent drivers by studying the visual behavior of the drivers under various passenger presence and passenger type conditions. The following research hypotheses were formulated for the driver's visual behavior: (1) the presence of a peer passenger increases the duration of looks away from the forward roadway and (2) the presence of a peer passenger narrows the driver's visual scanning range.

Method

Participants

Sixty-six participants were recruited from the Ann Arbor, MI, United States, area. Eligible participants were 16- to 19-year-old male high school students ($M = 16.97$; $SD = .57$) who had held a Level 2 Michigan driver license (allows independent driving with restrictions) for 4–9 months, drove at least twice a week on average, and had normal vision or corrected-to-normal vision. Participant assent and parental consent were required. Participants received compensation of $50.00 for a study visit lasting 150–180 minutes. The University of Michigan Behavioral Sciences/Health Sciences Institutional Review Board approved the study protocol.

Fifty-eight participants were included in the final analyses, seven being excluded due to simulator sickness or technical issues, and one participant being excluded due to parental report of a previous autism spectrum diagnosis that was not reported during screening. Sample demographics are listed in Table 1.

Table 1
Sample demographic characteristics ($N = 58$)

	Total	Study condition			
		Risk-averse passenger (n = 31)		Risk-accepting passenger (n = 27)	
	N	n	%	n	%
Race					
Black	4	4	100.0	0	.0
White	46	21	44.7	25	54.4
Asian	3	2	66.7	1	33.3
Other	2	2	100.0	0	.0
Hispanic/Latino					
Yes	4	3	75.0	1	25.0
No	53	27	50.0	26	49.1
Age (years)					
16	37	21	60.0	16	40.0
17	15	7	46.7	8	53.3
18	4	3	75.0	1	25.0

The numbers may not add to the total due to missing values. Chi-square tests revealed no significant differences, but the results should be used with caution because many cell sizes are <5.

Apparatus

Driving simulator. A fixed-base, high-fidelity Drive Safety driving simulator consisting of the front three quarters of the body and the front interior of a sedan was used. Three screens were located in front of the car and one screen behind the car onto which were projected the simulated road scenes at 60 Hz and at 1024×768 pixels resolution and provided 120° of forward field of view and 40° of rear field-of-view visible through the side and rearview mirrors (Figure 1A).

Simulated drives. The protocol required participants to drive three simulated worlds. The first was a 5- to 10-minute practice drive to acclimatize the participants to the simulator. The second and the third worlds were experimental drives about 15–20 minutes each. These worlds represented an urban setting including a series of signalized intersections with ambient traffic and relevant cultural elements (e.g., buildings, trees, signs and pedestrians). The intersections were placed along a straight path to preclude left or right turns during the drive, and the drives were programed to minimize any chance of crashes or other events that could interrupt a drive.

Eye tracker. A remotely mounted eye tracking system (Smart Eye AB) was integrated into the driving simulator (Figure 1B). Three infrared cameras mounted inside the vehicle monitored the driver's face. The eye tracking software calculated and recorded the driver's gaze location at a frequency of 60 Hz.

Study design

Participants were randomly assigned to one of the two passenger type conditions: risk accepting and risk averse. There were also two within-subject conditions: passenger drive, in which a confederate passenger was in the car with the participant, and solo drive, in which the participant was in the car alone. Participants were randomly assigned and counterbalanced to two drive orders: passenger drive first followed by solo drive and solo drive first followed by passenger drive.

Procedure

One young-looking male confederate (appearing 16–18 years old) was trained to portray the passenger in both conditions, that