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Teen drivers' awareness of vehicle instrumentation in naturalistic research

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ABSTRACT

Introduction: Naturalistic driving methods require the installation of instruments and cameras in vehicles to record driving behavior. A critical, yet unexamined issue in naturalistic driving research is the extent to which the vehicle instruments and cameras used for naturalistic methods change human behavior. We sought to describe the degree to which teenage participants' self-reported awareness of vehicle instrumentation changes over time, and whether that awareness was associated with driving behaviors. *Method:* Forty-two newly-licensed teenage drivers participated in an 18-month naturalistic driving study. Data on driving behaviors including crash/near-crashes and elevated gravitational force (g-force) events rates were collected over the study period. At the end of the study, participants were asked to rate the extent to which they were aware of instruments in the vehicle at four time points. They were also asked to describe their own and their passengers' perceptions of the instrumentation in the vehicle during an in-depth interview. The number of critical event button presses was used as a secondary measure of camera awareness. The association between self-reported awareness of the instrumentation and objectively measured driving behaviors was tested using correlations and linear mixed models. *Results:* Most participants' reported that their awareness of vehicle instrumentation declined across the duration of the 18-month study. Their awareness increased in response to their passengers' concerns about the cameras or if they were involved in a crash. The number of the critical event button presses was initially high and declined rapidly. There was no correlation between driver's awareness of instrumentation and their crash and near-crash rate or elevated g-force events rate. *Conclusion:* Awareness was not associated with crash and near-crash rates or elevated g-force event rates, consistent with having no effect on this measure of driving performance. *Practical applications:* Naturalistic driving studies are likely to yield valid measurements of driving behavior.

1. Problem

The question of whether direct observation influences human behavior is of enduring interest (McCambridge, Witton, & Elbourne, 2014). The phenomenon was first described by Mayo when researching factory workers in Hawthorne, Illinois, where he found that attention of any sort increased factory workers' effort (Mayo, 1933), and it has remained a topic of interest to behavioral scientists. Naturalistic driving studies require the use of in-vehicle cameras and instrumentation that are visible to study participants for the duration of data collection. As the use of naturalistic driving methods has increased around the world (Eenink, Barnard, Baumann, Augros, & Utesch, 2014; National Academies of Science Engineering and Medicine, 2012; University of New South Wales; Australia, 2017), the effect of cameras and vehicle instrumentation on driver behavior has become increasingly relevant.

A common concern in naturalistic driving is that awareness of being observed may affect driving behavior. However, little is known about drivers' awareness of the instrumentation in their vehicle, and the influence this may have on their behavior. Notably, video footage of crashes shows drivers engaging in risky, and at times, illegal behaviors (Klauer et al., 2014; Simons-Morton et al., 2011). This suggests that at least some drivers forget or disregard the presence of cameras and instruments and drive as they normally would some of the time. It is also plausible that the presence of a camera may encourage risky behaviors by providing an imagined audience for a driver. Participants in the 100-Car Naturalistic Driving Study drove cautiously for the first few hours of data collection, based on their accelerometer data, suggesting there may have been a short-term moderation in this risky driving behavior (Neale, Dingus, Klauer, Sudweeks, & Goodman, 2005).

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Novice teenage drivers are at much higher crash risk when compared to experienced adult drivers; crash rates per mile driven for 16- to 19-year-olds are four times the rates for adult drivers (Insurance Institute for Highway Safety, 2015). Naturalistic driving methods are ideal for studying this unique population as they offer detailed and accurate precrash information, including objective information about driving behavior, as well as exposure information (Campbell, 2012). Findings from these studies have informed national policy on distracted driving (National Highway Traffic Safety Administration [NHTSA], 2012; U.S. Department of Transportation, 2017). However, the extent to which teen drivers' awareness of instruments in their vehicles may have influenced their driving behavior in unknown.

The purpose of this study was to examine teen drivers' awareness of instrumentation in their vehicles while they participated in a naturalistic driving study, using a mixed methods approach. Qualitative data about teens' awareness of the cameras and instruments in the vehicles were collected during an in-depth interview. Quantitative data about teen drivers' crashes and near-crashes were collected throughout the study. The association between participants' awareness of the instrumentation in their vehicle and their driving performance, measured by observed crash and near crash rates, was tested. The number of critical event button presses was used as a secondary measure of camera awareness.

2. Method

2.1. Participants

A convenience sample of 42 newly licensed male and female drivers participated in an 18-month study of new drivers, that included vehicle instrumentation, periodic surveys, test track driving assessment, and a semi-structured exit interview (The Naturalistic Teen Driving Study; Lee, Simons-Morton, Klauer, Ouimet, & Dingus, 2011). Participants were required to be younger than 17 years of age and obtained a provisional driver's license allowing independent driving within the past three weeks. Sampling was stratified in order to have similar numbers of males and females. Drivers with diagnosed attention deficit disorder, with or without hyperactivity, were excluded. Identical twins (which would make it difficult to distinguish when coding the identity of the driver), those who needed to enter restricted areas (i.e., that do not allow cameras for security reasons), and only access to a pick-up truck (due to lack of a concealed space to install the instrumentation) were also excluded.

2.2. 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. The confidentiality section of the consent form for teenagers contained an extensive description of the steps that have been taken to treat the data gathered in the study confidentially (e.g. Certificate of Confidentiality that prevents authorities from subpoenaing study data) and that driving videos would not be released without participants' written consent. The final paragraph of the confidentiality section stated that investigators may disclose information to authorities if offenses such as child abuse or habitual driving under the influence are observed.

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 and other tasks, such as test track assessments of driving behavior. 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.

3. Self-reported data

3.1. Qualitative interviews

The 41 (one participant was lost to follow up and did not complete the exit interview) interviews analyzed in the current study were conducted at the end of the 18-month study on driving behavior. The interview was designed as an exit interview with direct questions regarding drivers' experiences in the study. The interview questions about participants' awareness of instrumentation comprised one of seven sections in the interview guide. Other topics included teens' perceptions of their parents and peers as passengers, and cell phone use while driving. A trained research assistant at the Virginia Tech Transportation Institute conducted the interviews.

The focus of this study was drivers' awareness of the instrumentation in the vehicle during the course of the 18 month study (see Table 1 for questions). To enhance recall, participants were asked to draw their awareness of the instruments on a graph, which was given to the interviewer (see Fig. 1). The shape of the graph was used by the interviewer as the basis for the questions that followed. For example, if there was a general pattern (i.e., increase or decrease) the interviewer would ask participants why it changed. After each question block, the interviewer asked participants if they have anything to add. Teens were asked about their passengers' awareness of the cameras and instruments in the vehicle and how the instrumentation may have effected passengers' behavior.

The average length of each interview was about 46 min. Interviews were digitally recorded and professionally transcribed. Transcripts were entered into ATLAS.ti software (Version 7.0). This software allows text to be coded and retrieved for ease of summarization and interpretation (Strauss & Corbin, 1998). Content analysis of participants' responses was used taking an inductive approach. Our research team, including an injury epidemiologist with an expertise in young driver research and a developmental psychologist with expertise in qualitative methods and adolescence, reviewed four transcripts (2 male, 2 female) to identify an initial list of themes. A coding manual was developed based on these four interviews and modified as subsequent interviews were coded. Additional codes were added to represent subthemes and

Table 1
Structured interview instructions for interviewer and questions.

Interviewer looks at the graphs drawn by the participant and asks questions accordingly for each of the four segments (1, 6, 12 and 18 months) of the graph and each peak. If there is a general pattern (i.e., increase, decrease, or stability over time) in the three segments, interviewer can ask one general question. After each question block, interview asks participants if they have anything to add.
1. Participants' awareness of cameras and other instruments
From your drawing, it appears that your awareness of the instruments [*describe graph*
a. The slope
- [changed over time]: Why did it change?
- [didn't change over time]: Why did it stay the same?
b. Over the past 18 months, were there specific moments at which you thought more about the cameras and instruments while driving.
- [If yes]: How long did that heightened awareness last?
2. Passengers' awareness of cameras and other instruments
From your drawing, it appears that your passengers' awareness of the instruments [*describe graph*]
a. The slope
- [changed over time]: Why did it change?
- [didn't change over time]: Why did it stay the same?
b. Over the past 18 months, were there specific moments at which you thought more about the cameras and instruments while driving.
- [If yes]: How long did that heightened awareness last?
- How do you know?
- What were their comments about it?
- How do you think their behavior in your vehicle was affected by the cameras or instruments?
- Were there other moments at which your teenage passengers mentioned or acted as if they were aware of the cameras or instruments?

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