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Naturalistic assessment of the learner license period

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ABSTRACT

The purpose of this study was to describe the characteristics and progression of practice driving during the learner license period in a sample of teenagers. During the first and last 10 h of practice driving, we examined (1) the amount, variety and complexity of conditions of practice; (2) the nature of parental instruction; and (3) errors that teens made while driving. Data were collected from 90 teens and 131 parents living in Virginia, USA, using in-vehicle cameras, audio recorders, GPS and trip recorders. Based on data collected from the instrumented vehicles, teens practiced for 46.6 h on average, slightly higher than the GDL requirement for their jurisdiction, though half did not complete the required 45 h of practice and only 17% completed the required 15 h of night time driving. Exposure to diverse roadways increased over the practice driving period, which averaged 10.6 months. Most driving instruction occurred in reaction to specific driving situations, such as navigating and identifying hazards, and could be characterized as co-driving. Higher order instruction, which relates to the tactics or strategies for safe driving, was less frequent, but remained stable through the practice driving period. Instruction of all forms was more likely following an elevated gravitational force (g-force) event. Errors decreased over time, suggesting improvements in manual and judgment skills, but engagement in potentially distracting secondary tasks increased (when an adult was in the vehicle). A small percentage of trips occurred with no passenger in the front seat, and the g-force rate during these trips was almost 5 times higher than trips with an adult front-seat passenger. Taken collectively, these findings indicate (1) most teens got at least the required amount of supervised practice, but some did not; (2) instruction was mainly reactive and included some higher order instruction; (3) teens driving skills improved despite increased exposure to complex driving conditions, but secondary tasks also increased. Opportunities remained for improving the quality and variability in supervision and enhancing the development of skills during the lengthy period of practice.

1. Introduction

The age when teenagers begin to drive corresponds to a period of particular vulnerability to motor vehicle crash injury. Graduated driver licensing (GDL) seeks to reduce the risks facing novice teenage drivers by phasing in their exposure to increasingly demanding environments (Johnson and Jones, 2011). GDL requires progression through a learner license stage, where driving occurs only under adult supervision (typically a parent), to a provisional stage where teens can drive independently, with limited exposure to risky driving environments (e.g., late night driving, driving with teenage passengers; electronic secondary tasks), and finally to full independent licensure.

Learning to drive involves psychological, sociological, perceptual and motor processes. Learning theory provides insight into how novices learn, and while there are many competing theoretical frameworks, the classic conceptualization by Fitts and Posner indicates that learning occurs in three overlapping stages described as cognitive, associative and autonomous (Fitts and Posner, 1967). The cognitive stage is typified by the development of explicit knowledge, which is defined as knowing what to do and how to do it under simple conditions. Associative learning focuses on the details, sequence and application of explicit knowledge under varying and complex conditions. The autonomous stage, which can occur only after substantial practice and experience, represents the internalization of associative learning, such that learners respond effortlessly, without consciously thinking about their behavior (Simons-Morton and Ehsani, 2016).

Research on the development of expertise indicates that learning is a gradual process that occurs through extensive practice (Ericsson et al., 2006). A drivers' ability to identify and manage risks, and drive safely is therefore likely to increase as they accumulate experience (Elvik, 2006). To encourage practice, many countries requires teens to complete a certain number of hours (for example, 50 h in the majority of US

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states) during the learner stage of GDL. When practice occurs in a variety of increasingly demanding conditions, and is combined with feedback from parent supervisors, improvements in driving performance are most likely to be achieved (Ericsson et al., 1993). Therefore, the amount of experience that a learner accumulates, the variety of conditions in which their practice occurs, and the nature of parental instruction they receive can be considered as the building blocks of the learner period.

Despite the fact that an extended learner period has been widely adopted in the U.S. and in several other countries as part of GDL, surprisingly little is known about the characteristics and progression of practice, and what is actually learned during the learner license stage. Research about how much teens actually practice is sparse and has relied mainly on self-reported measures (Waller et al., 2000; Williams et al., 2002; McCartt et al., 2007; Scott-Parker et al., 2011; Jacobsohn et al., 2012; Bates et al., 2014). Self-reported accounts about practice driving may not be entirely accurate, given the fallibility of memory (Staplin et al., 2008), so objective data are needed about the number of hours teens practice. Further, Mirman and colleagues argue that a single, crude measure of supervision amount (either as hours of distance driven) does not account for practice diversity or instructional quality (Mirman et al., 2014a,b,c).

Studies measuring practice diversity are rare, and have relied self-reported assessment of practice in different driving environments (Mirman et al., 2012, 2014a,b,c). Currently, the extent to which practice is repetitive, occurring on the same types of roads during the same time of day, or provides exposure to a variety of driving conditions is unknown. It seems plausible that the first hours of practice may be devoted to learning basic vehicle control (Hall and West, 1996), and from then onwards, novices would be expected gradually to be introduced to increasingly challenging driving conditions. However, in a rare naturalistic driving study, Goodwin and Foss found practice driving was characterized mainly by routine driving trips on familiar roads, occurring in minimally challenging environments (Goodwin et al., 2010). Basically, parents seemed focused on keeping their teens safe while they accumulated minimally challenging experience. Given the paucity of research on the topic, the need for objective measures of progression and driving diversity are needed to capture the characteristics and context of practice.

In addition to the amount and conditions of practice driving, the quality of driving instruction provided by parents during the learner period merits attention (Tronsmoen, 2011; Mirman and Kay, 2012; Scott-Parker et al., 2014; Ehsani et al., 2015). Survey studies from the U.S. and Norway found that parents tended to emphasize basic concepts, such as vehicle handling and control, and placed little emphasis on higher level skills, such hazard anticipation (Tronsmoen, 2011; Mirman and Kay, 2012). In their naturalistic study of parents supervising their teen drivers, Goodwin and Foss also found that instruction tended to focus on basic concepts, rather than on higher order skills such as managing a safe gap between vehicles (Goodwin et al., 2014). However, this study lacked the capacity to record continuously and could not assess routine driving given the relatively small sample of observations. Therefore, the extent to which instruction varied according to driving conditions, individual characteristics, or changes over time, has not been previously described.

Novices drivers frequently make mistakes (Curry et al., 2011), and provided these are not catastrophic, driving errors may provide useful opportunities for feedback as well as being an objective measure of learning. As skills and confidence improve, learner drivers' are more likely to accept greater challenges, experience more demands and possibly make different mistakes. To identify whether learners are advancing in their skills, objective measures of driving errors and the situations in which they occur are needed. On-road assessments developed by licensing authorities and for experimental studies (Hagge, 1994; Mirman et al., 2014a,b,c) have developed protocols for the measurement of driving errors in one-off assessments, but previous research has not measured errors while learning to drive as novices gain experience over time.

A better understanding of the amount, diversity and context of practice obtained by novice teen drivers, and the nature of the instruction provided by parents, is essential to improving the learner license period. Measurement of driving errors and the situations in which they occur would also inform how learning advances and skills acquired. Building on methodological approaches developed by Goodwin and Foss (Goodwin et al., 2010, 2014), the goals of the current study were to describe the following characteristics of practice driving over time: (1) objectively measure the amount and conditions of practice driving; (2) the amount and type of instruction provided by parents; and (3) improvements in teen driving skills.

2. Materials and methods

The vehicles of teenage drivers in southwestern Virginia, USA were instrumented with data acquisition systems (described in detail below) within three weeks of the teen obtaining a learner's permit. Participants were instructed to drive normally. In Virginia, teenage drivers below the age of 18 must hold a learner's permit at least nine months, and practice a minimum of 45 h under the supervision of a licensed adult, of which 15 h should occur at night (Virginia Department of Motor Vehicles, 2016).

2.1. Participants and selection criteria

The study required the participation of teenage drivers and at least one of their parents. Recruitment was conducted in local newspapers and high schools in southwestern Virginia, USA. Teen participants were initially screened in a telephone interview for eligibility using the following inclusion criteria: (a) being between 15.5 and 16.1 years old; (b) holding a learner driver's license for no more than three weeks; (c) having at least 20/40 corrected vision; (d) having at least one parent willing and able to participate; (e) access to a vehicle expected to survive mechanically for at least 18 months; (f) residing within a one-hour drive of the research center or satellite location; and (g) holding liability insurance on the vehicle to be used in the study (required by state law). Parent participants were required to (1) have a valid U.S. driver's license, vehicle insurance, and proof of ownership (2) have a child who was eligible and willing to participate in the study and who was allowed by their parent to participate (3) have at least one of their vehicles equipped with instrumentation required for the study.

Participants were excluded based on the prescreen telephone interview or these reasons: (a) diagnosis of attention deficit disorder (ADD) or attention deficit hyperactivity disorder (ADHD); (b) an identical twin (which would make it difficult to distinguish participants during coding); and (c) the need to enter restricted areas (i.e., that do not allow cameras for security reasons). Participant recruitment was stratified to have a similar number of male and female teenage drivers. A total of 298 individuals responded to recruitment efforts, of which 90 fulfilled the eligibility criteria and were enrolled in the study. In 41 families, a second parent consented to having their driving data collected but did not complete any other elements of the study. Data were collected from January 2011 to August 2014.

2.2. Consent and compensation

Three consent forms were required for the study: parental consent and teenagers assent for their participation, and an adult consent form for parent participation. Teenager assent was obtained separately from the parent to ensure their participation was voluntary, and free of parental coercion. Teenage participants received $800 for completing the study, paid to them in installments as they completed key milestones. The protocol was approved by the Virginia Tech Institutional Review Board for the Protection of Human Subjects.