Driving Self-Perception: Increasing the Value of Driving Lessons for Novice Drivers

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ABSTRACT
Learning sciences and intuition commonly support the idea that one can learn more effectively by knowing his or her current strengths and weaknesses (self-perception). This concept has seldom been applied to procedural knowledge tasks such as driving, but it can benefit students by maximizing their learning capability. To validate the hypothesis that a student driver with a more accurate self-perception of his driving skill may accelerate the improvement of the skill, we first conducted interviews with driving instructors and a student driver, and second we deployed a rating application of students' driving skill to student drivers and their instructors. The analysis shows that student self-perception accuracy improves with each lesson ($\bar{x}$ = 8% per lesson), and there is a moderate positive correlation between improved self-perception accuracy and improvement in driving skill (R = .41). Implications for potential applications to provide feedback to support driving students are discussed.

Author Keywords
Metacognition; procedural tasks; self-perception; skill.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

New drivers are disproportionately responsible for accidents on the road. The highest probability of a driver crashing occurs within the first 6 months of becoming licensed, and motor-vehicle fatalities are the leading cause of death for persons under age 19 [5]. These accidents are also phenomenally expensive for the victims, their families, and society [4]. Students can improve their driving skills before becoming licensed by taking on-the-road lessons with trained and certified instructors. However, these lessons are often short (typically lasting an hour each) and expensive (may cost upwards of $65 an hour). US state law may require students to take lessons before a road test, and any student who does not pass the road test may need to pay for additional lessons. As each lesson is short and expensive, it is important to maximize the learning capability of each one.

In learning science, research has found that people with accurate self-perception through metacognition are able to gain more knowledge [11]. We believe that this theory should apply to driving lessons as well; specifically, the more accurate one's self perception of her driving skill is, the faster she will be able to improve upon her driving skill. With this framing, we can explore methods to increase the self-perception accuracy of student drivers to learn faster, and validate this hypothesis.

In this study, we investigate the relationship between accuracy of self-perception and driving skill improvement, focusing on the time that a novice driver begins learning to drive. In particular, we approach this problem from two avenues. First, in a qualitative interview setting, we spoke with 4 driving instructors and a student driver about the importance of self-perception of driving skill and how feedback in lessons improves the accuracy of self-perception. Second, we investigate the accuracy of a student's self-perception as the student gains more driving skill in driving lessons via a questionnaire. We found that self-perception is correlated with driving skill, and that improvements to self-perception are correlated with commensurate improvements to driving skill.

METACOGNITION AND DRIVING

Metacognitive Knowledge Monitoring

In learning science, metacognition is the ability to monitor, evaluate, and make plans for one's learning [11]. It is commonly broken down into two or three sub-processes, one of which is Metacognitive Knowledge Monitoring (MKM) [9]. MKM describes the process of differentiating of what one knows and does not know. Many studies have found that MKM is crucial for students to learn effectively [11]. This has been found consistently in the academic domain, from higher education to vocational skills [11]. Isaacson and Fujita succinctly state the mechanism of action: "Students who are skillful at academic self-regulation understand their strengths and weaknesses as learners as well as the demands of the specific tasks" [6]. However, despite the finding that metacognitive skills are useful across domains of declarative knowledge tasks [12], little research has focused on metacognition as it relates to

procedural tasks, such as driving. In one study, Soliman and Mathna found that by training drivers in metacognitive strategy, the drivers became more situationally aware and reduced their driving infractions [10]. We could not identify any research on how metacognitive ability affects novice driver learning, despite its great potential and benefit. As the learning opportunity for each driving lesson needs to be maximized, driving skill is one key area where studying metacognitive knowledge monitoring could offer direction for future applications.

Self-Perception and Driving Skill

Like all drivers, novice drivers have a skewed self-perception of their own skills: they overestimate their skill levels and underestimate their risks in traffic [3, 7, 8]. Overestimation occurs especially when measured with questionnaires, because drivers believe that driving safety is largely beyond their personal control, because of cognitive processes (such as memory recall), or situational factors (*e.g.*, social desirability of responses) [13].

In particular for novice drivers, De Craen showed that they recognize that their skills are not as good as the average driver on *questionnaires*, but they do overestimate when compared to their actual driving *performance* [2]. Unlike other drivers however, novice drivers do not have the experience to compensate for their overconfidence. Those novice drivers who are overconfident in their driving skills are significantly more likely to crash. De Craen conducted a longitudinal experiment of novice (but licensed) drivers and found that 18% of the well-calibrated drivers, compared to 50% of the overconfident drivers, reported crashing during their first two years after becoming licensed [1]. Interestingly, she found that over that two-year period, novice drivers' accuracy of their self-perception did not increase. While these studies clearly show that the accuracy of a student driver's perception of his or her skills is connected with driving performance, no research could be found that shows how gaining that self-perception can cause more rapid learning among novice (and non-licensed) drivers.

METHODS

We investigated the relationship between student self-perception of driving skill and learning rate in two ways.

Method 1: Interviews with Driving Instructors and Students

Participants included 4 driving instructors and 1 student driver. Instructors were recruited through an internet search for local driving schools, and then via phone. The instructors have an average of 9.5 years' experience. The student was recruited by the instructor. Interview notes and audio transcripts were synthesized to uncover higher level themes generally about factors that make for a more impactful lesson, and specifically about the role of self-perception in learning driving skills. Instructors and students were not compensated for the interviews.

Method 2: Post-Lesson Questionnaire

Participants included data from 1 instructor and 18 driving students, who served as our novice driver population. The other recruited driving instructors did not record data with enough consistency to allow for longitudinal comparisons. The students' ages ranged from 18 to 55 and had driving experience levels from 15 minutes to several hours prior to beginning their lessons. After a driving lesson, the instructor and the student took a survey that asks analogous questions to both participants in order to compare the student's perception of his driving skill to his actual performance, as rated by the instructor. Questions included "How well did you do generally on 1-lane roads?" and "How well did you do at maneuvering in heavy traffic?" Self-perception was measured by the difference in the student and instructor scores; performance was measured by the instructor score. To process the data, we correlated the differences in the accuracy of the student's perception from lesson n to lesson n+1 to improvement from lesson n to lesson n+1 as rated by the instructor.

RESULTS

From our interviews and analysis of post-lesson questionnaire responses, we found a moderate relationship between self-perception and driving performance, and discovered implications for potential applications.

Interviews with Driving Instructors and Students

Self-perception is crucial for learning driving skills: Both instructors and student drivers feel that the student's self-perception of his/her driving skill is an important factor in determining how quickly that student can learn. Only through knowing one's strengths and weaknesses can a person understand what skills to focus on. Without prompting, Instructor A, a driving instructor in the middle size city in US, noted, "*[When students] know the problem, they're on their way to fixing it. That's half the battle.*" A student who had just finished a lesson understood the set of skills that were necessary, but acknowledged that she did not yet know how to improve at those skills: "*I think I'm doing better at slowing down, [but] I'm not so good at maneuvering. […] A lot of these mistakes will happen again, so I need to know what to do in these situations.*" As student drivers and instructors believe that self-perception is an important component to learning how to drive, it may be useful to monitor and aid students' metacognitive knowledge as an indicator of their progress.

Student-instructor communication is extremely important: Communication between student and instructor is very important in developing self-perception of driving skill. Specifically, feedback needs to be presented soon after a good or bad driving maneuver occurs, and the instructor's demeanor needs to be calm and collected. Instructor B, a prominent professor of Highway Safety, trains driving instructors how to teach driving skills effectively. He noted that "*The immediate feedback is [for students] critical. Of course at the end [of the lesson], a summary […] is helpful,*

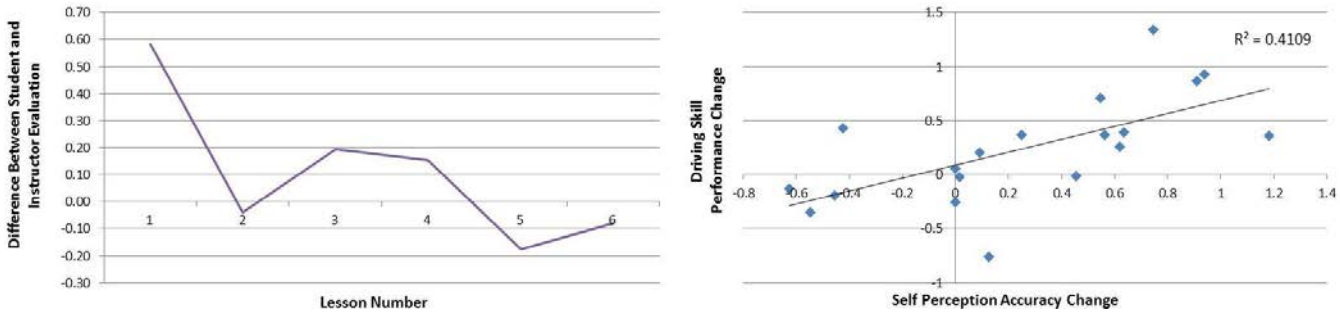

Figure 1. (a) Left: Difference in Student and Instructor valuation lesson to lesson. (b) Right: Correlation between improved self-perception accuracy and improved driving skill

but the immediate feedback is much more important." Those students who do not listen to this feedback are bound to be worse drivers: "*I've had a lot [of students who don't listen], and I know they're going to be horrible, aggressive, awful drivers*," noted Instructor A. However, one difficulty in providing feedback is often that the risk of a poorly executed maneuver does not reduce immediately. Student drivers can fail to absorb immediate feedback because they are cognitively overloaded. When young student drivers practice with their parents to gain more experience, the parents often become anxious in these situations, and consequently react poorly. In more than one interview, yelling was mentioned as a common occurrence. This reaction overwhelms and inhibits the student driver from learning the necessary skill. Instructor C overcomes this cognitive overload by focusing early feedback on reassurance, and then by having the student repeat the maneuver until it improves. Clearly, any application which focuses on aiding student driver self-perception will need to provide feedback soon after a pertinent teaching event, but will also need to overcome being ignored or becoming a distraction which could create further driving risk. One opportunity could be for the application to provide ambient feedback (auditory or visual) that the driver could choose to ignore in moments that require significant concentration.

Driving lessons should teach perceptual driving skills: Instructors implicitly made a distinction between two types of skills in driving – motor versus perceptual. The former describes the skill necessary to successfully pilot the vehicle according to physics and physical comfort of the driver and passengers. The latter is a higher level skill that encompasses anticipating and managing risks while driving by paying close attention to upcoming obstacles. Instructor B drew a strong distinction: "*Operating a vehicle you can teach to a 2 year old. If you can get a student to identify hazards, that's more important*." Instructor C concurred: "*We're not teaching them how to drive; we're teaching them how to make decisions*." While students do improve their motor skills during lessons with instructors, those skills could be taught outside of the lesson, potentially when driving with other family members. Instead, one primary benefit of driving is that perceptual skills can be focused on. While there is a significant technical challenge to detecting upcoming road hazards and understanding if the novice driver is aware of them, one potential application may focus on instructing parents how to coach their children in higher-level perceptual driving skills. As long as the parent remains calm, these home lessons could become more impactful, potentially as much as an instructor-led lesson.

Analysis of the Post-questionnaire Responses

By analyzing the post-questionnaire data, we found both that student drivers' self-perception becomes more accurate as they progress through their driving lessons ($\bar{x}$ = 8% per lesson), and that there is a moderate positive correlation between self-perception improvement and driving skill improvement (R = .41). Figure 1a demonstrates that the accuracy of student drivers' self-perception increases over time. A score of 0 represents no difference between the student's rating on a skill and the instructor's rating of the student on that same skill. Students tend to overestimate their skills, but their scores on their own driving practice gradually become more in-line with the instructor evaluations on the same driving practice. A few students (3, 17%) crossed from overestimation to underestimation or vice versa. Furthermore, an individual student may gain or lose accuracy about his or her self-perception from lesson to lesson, implying that the inter-lesson period may be important for solidifying the skills that were taught and applied during the lesson.

To focus more closely on the improvement that takes place at each lesson, we measured correlations between the accuracy changes of a student's self-perception and his change in skill as measured by the driving instructor. As shown in Figure 1b, the change of self-perception has a moderately strong correlation (R= .41) with the improvement of driving skill. As a student gains more knowledge about his skill distribution, his driving skills will improve. Interestingly, the skills questions which focus on knowledge of motor tasks (*e.g.*, "How well did you do at slowing properly before turns?") are just as highly correlative (average of R= .33 v R= .32) as those

that focus on perceptual driving skills (*e.g.*, "How well did you do at scanning the road ahead"). Self-perception, then, is an important correlate of both lower level motor skills and higher level perceptual tasks. These findings are similar to the findings from the qualitative interviews, and suggest that an application which allows the driving student to record his or her self-perception of low- and high-level driving skills could be useful in tracking improvement of actual driving skill. The application could provide real time and summative feedback to the students, parents, and perhaps even insurance companies.

DISCUSSION

Our research shows a moderate correlation between the accuracy of a student's self-perception of her driving skill, and objective performance on that skill. While this study design cannot infer a causal relationship either way, when analyzed with the findings from the interviews, we find that further investigation is warranted to identify the potential for an application to help students learn more quickly by helping improve their self-perception.

Further research in the area of human-computer interaction can focus on the interaction between parents and their children who are learning how to drive. While it may be difficult to reduce parental anxiety, an application providing an objective viewpoint and cues to teach their child about perceptual driving skills for the parent's feedback might be impactful. A user's own smartphone could be leveraged to detect student drivers' driving behaviors and offer feedback.

In our study, we assumed that the instructor's evaluation of student drivers' driving performance is accurate. However, after meeting with several driving instructors, each of whom had different training, we recognized that there is variance in evaluation to be more subjective on the driving skills. Furthermore, we only analyzed data from one driving instructor. Both of these factors could have led to bias in the results.

CONCLUSION

In this work, we showed that novice driver self-perception is important for learning driving skills and the improvement of self-perception is correlated with an improvement in driving skill. The value of driving lessons may be increased with an application that can help students or their parents provide objective, constructive feedback in order that the student may learn more efficiently.

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