INITIAL VIEWS ON TEEN DRIVERS' PERCEIVED VALUE OF ADVANCED DRIVER ASSISTANCE SYSTEMS

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ABSTRACT

Motor vehicle crashes remain the leading cause of death among teens 16-20 years of age (CDC 2015). It is widely accepted that this risk stems from inexperience and driving skill deficits among novice drivers. Recently developed advanced driver assistance systems (ADAS) have the potential to compensate for skill deficits and reduce overall crash risk. Yet, ADAS is only effective if drivers are willing to use it. Limited research has been conducted on the suitability of ADAS for teen drivers. The goal of this study is to identify teen drivers' perceived need for ADAS, receptiveness to in-vehicle technology, and intervention preferences. The long-term goal is to understand public perceptions and barriers to ADAS use and to help determine how these systems must evolve to meet the needs of the riskiest driving populations.

Three focus groups (N = 24) were conducted with licensed teen drivers aged 16-19 years. Discussion topics included views related to the impact of ADAS on teen driving behavior as well as technology preferences. Discussions were transcribed; the team used conventional content analysis and open coding methods to identify 12 coding domains and code transcripts with NVivo 10. This paper will focus on 3 themes: Views on customization of ADAS; ADAS as supplemental assistance; and overall value of ADAS. Inter Rater Reliability testing showed moderate to very high Kappa Scores.

Overall, participants recognized potential benefits of ADAS, including improved safety and crash reduction. Participants suggested that ADAS is still developing and therefore, at this stage, they would prefer it to be used as a supplemental aid to the driver, who will retain ultimate control. Participants overall agreed that ADAS technologies should be customizable to the needs and preferences of the end-user, and yet all agreed that this technology holds value and could be instrumental in reducing death and injury from motor vehicle crashes.

This study elicited important end-user viewpoints by exploring the intersection between advanced automobile safety technology and human perception for the particular use case of teen drivers. This understanding will ultimately advance the safety of teen drivers by identifying barriers to effective ADAS use.

INTRODUCTION

Motor vehicle crashes remain the leading cause of death among teens 16-20 years of age (CDC 2015). It is widely accepted that this risk stems from inexperience and driving skill deficits among novice drivers. Advanced driver assistance systems (ADAS), including warning systems – such as forward collision warning (FCW) and lane departure warning (LDW) – and automated features – such as automatic emergency braking (AEB)– have the potential to compensate for teen driver skill deficits and reduce overall crash risk. However, limited research has been conducted on the efficacy of ADAS and novice teen drivers – the population with the greatest potential to benefit from such systems. ADAS is only effective if drivers are willing to purchase and use ADAS and are receptive to how ADAS presents warnings or autonomously corrects for driver misbehavior.

A significant study involving novice teen drivers and ADAS, the Teen Integrated Vehicle-Based Safety System (IVBSS) Field Operations Test (Buonarosa 2013), evaluated the effect of integrated crash warning systems on teen driving behavior. Warning systems had a small positive effect, possibly because the warnings delivery mode was not well calibrated to the teens' intervention preferences. Results from a post-study survey showed that, while teens were generally receptive to the integrated warnings, certain warnings, like FCW – arguably the most important for teen drivers – were not viewed as favorable as blind spot detection and LDW.

To gain further insight into this topic, the current study utilized focus groups to conduct a qualitative assessment of novice teen drivers' perceptions of ADAS to help determine how ADAS design could best meet the needs and preferences of novice teen drivers and maximize this population's acceptance of and compliance with ADAS. Ultimately, identifying these preferences will allow ADAS designers to create systems that have a greater likelihood of reducing teen driver injury and death on the roadways.

METHODS

All study protocol were reviewed and approved by the Internal Review Board at CHOP. Exclusion criteria included: not fluent in written or spoken English; and subjects who, in the opinion of the Investigator, may be non-compliant with study schedules or procedures.

We employed standard focus group methodology (Krueger 2000) to study the teen population, since group interaction and the cross-stimulation of ideas would likely foster discussion on this novel topic. We conducted three focus groups with teens (16-19 years old) with a full driver's license.

Prior to the focus groups, participants completed a brief demographic survey, then observed a presentation on ADAS most common in the US, including information from MyCarDoesWhat.org (website created by The National Safety Council and the University of Iowa). This presentation aimed to ensure participants had basic knowledge about ADAS and to keep discussion focused on relevant ADAS options. The moderator guide included questions about ADAS technologies and their potential behavioral impacts, and focus groups were facilitated by the lead qualitative researcher, assisted by the lead engineer, and lasted 90 minutes. Saturation was reached by the final group, as no significant new topics were raised by study participants in answer to the line of questions.

Each focus group was audio-recorded. The recording was sent via a secure online website to a transcription service (all transcripts were de-identified). Due to the novel nature of the research question and the limited relevant literature, researchers chose conventional content analysis methodology and approached analysis through an inductive approach using open coding (Hsieh and Shannon 2005).

Using a team-developed codebook to provide guidance and consistency, two coders used NVivo 10 to independently code the transcripts. During early stages of coding, the team regularly discussed the coding process to address questions and reconcile differences in interpretation. Nodes were refined based on experience with the data, and the final version of the codebook was created. Two coders completed coding all three teen transcripts. Coded databases were merged and Inter Rater Reliability (IRR) testing was completed. After reconciliation, final IRR testing showed very high Kappa Scores on first teen transcript and moderate agreement on the second and third transcripts.

RESULTS

Twenty-four teens participated in the three focus groups (mean: 8; range: 5-11). See Table 1 for a demographic summary. Using open coding methodology, the team created a list of 12 coding domains based on focus group content (Table 2).

Table 1. Participant Demographics

Age (yrs)	17.6
No. of Participants	24 (11 F)
ADAS Experience	
Heard of ADAS	33%
Ridden in a car with ADAS	8%

Overall, the research team observed that teens are knowledgeable, opinionated consumers. They have some concerns about the technology as they perceive it may potentially fail. Therefore, they consider ADAS a supplemental aid and that the driver should retain ultimate control. Respondents repeatedly expressed a desire to tailor ADAS to their needs and preferences, but also emphasized that they see ADAS as a potentially powerful means to keep teens safer on the road and reduce death and injury from motor vehicle crashes, overall. While multiple themes emerged in the analysis, we chose to focus on the following three major themes in this paper: 1) ADAS Trusted as Supplemental Aid 2) Technology preferences -- Tailoring ADAS; and 3) Value of ADAS.

Theme 1: ADAS Trusted as Supplemental Aid

Teen participants showed initial skepticism about the technology since they have used technology on a daily basis and have both a comfort with it and some experience of technological malfunction. Participants' assessments of ADAS reliability were based on previous experience with technology, such as computers and cell phones and their sometimes-unpredictable operating system upgrades. As such, some teens said technology should be considered a tool that may have errors and may need continuous review and improvement. Given that premise, they felt that ADAS currently should be considered an aid to drivers and not fully relied upon. Teens repeatedly emphasized that until technology is further developed and the fleet has fully turned over, the driver should remain ultimately responsible for handling the car. One teen said, *"Just because it's helping us doesn't mean it's going to save us …It's not there to drive for us."* Teens expressed an underlying discomfort with perceived lack of control, despite study leaders' assurance that ADAS was there to assist, not take over, and drivers would not be forced to "fight with the car."

Theme 2: Technology preferences – Tailoring ADAS

Focus group participants were animated during discussions about technological preferences. They assumed ADAS might be oversensitive and become a distraction, and therefore a system that is modifiable might have the most success in their demographic. In fact, the idea that a hypersensitive ADAS system might create an annoyance was a significant thread in the discussion. Many teens believed early-stage

Table 2. Coding Domains and Definitions

Trust – Positive	Assumption that ADAS can be trusted to function in all conditions and make appropriate decisions in adverse situations. ADAS will evolve over time.
Trust - Negative	Humans are superior to machines; transitional fleet is risky; ADAS will not perform properly.
AST is Supplemental Assistance	AST should be used as a supplemental assistance not as the main mechanism for driving.
AST Effect on Driving Skill	Use of ADAS may have an impact on a new driver's skill development and awareness; opinions on new driver's learning on an ADAS equipped vehicle.
AST Effects on Behavior	ADAS may be a distraction or allow distracted driving; Drivers may become safer drivers.
Annoyance	Annoyance related to false alerts; hypersensitivity of technology; overstimulation from warning systems.
Data	System may be vulnerable to hackers; legal protections of driver records and data; data may provide useful feedback.
Fault in a crash	Who bears fault in a crash involving vehicle with AST?
Insurance Discount/Penalty	Receiving an insurance discount (or penalty) based on driving behavior or owning system.
Comments related to ADAS options	Specific discussion related to any of the ADAS options.
Customization	Ability to customize ADAS options, including an ADAS shut-off.
Value of ADAS	Comments about the inherent value in the technology, such as saving lives.

ADAS would be oversensitive, creating stress, overstimulation, and distraction for the driver, all of which could lead to confusion in interpreting the alerts. A teen said, *"But my concern is – there are several warning systems. So…would there be a different beep for each of them? And if it's like beep, then you're, 'Wait. Which one? Where am I messing up?'"* Some teens said they might respond to annoyance by ignoring or de-activating the system.

Given these anticipated concerns, many teens felt strongly that they would want to control over how the system is deployed and concluded that any ADAS system must be customizable. Many felt there should be an "on and off" option allowing the driver to decide whether the system was needed. However, some teens countered that there was no point in turning the technology off since it was already built it in, and it is there to help you while driving.

When asked if they would prefer a system with haptic/vibration, visual display, or auditory alerts, most teens preferred the idea of vibration plus visual. Auditory was the least popular since teens thought that with their music playing loudly, alerts could either be missed or too intrusive.

When asked to rank their preferences among the ADAS options mentioned in the initial presentation, the majority of teens chose drowsiness alert, followed closely by blind spot monitoring. Many teens talked about being tired at night, driving home after studying, or early morning drives to school; others said that they are most anxious about blind spots. Several teens agreed that drowsiness is not something they can control, and therefore it is something they'd be willing to trust ADAS to manage better than themselves. Overall, regardless of the type of warning chosen by individual teens, it was clear that the majority felt a customization option is crucial to customer acceptance.

Theme 3: Value of ADAS

A significant majority of teens recognized the inherent value of ADAS and other technological advances that will make driving safer for teens and others on the roadways. This sense was reflected in discussions about the flexibility technology can offer in adapting to individual needs; and about how technology, particularly advances in automotive technology, has benefited society. The participants expressed concerns and skepticism about these early stages, but overall they felt ADAS was likely worth the cost of purchase due to increased safety. One teen said, *"Even if it costs more…if it saves your life, it's pretty worth it. Because any cost is worth saving a life."* Participants looked forward to a time when most or all cars on the road have ADAS and can contribute to reducing injury and saving lives.

DISCUSSION/CONCLUSIONS

This study utilized focus group methodology to understand teen driver perceptions of new driving technologies to which they had little prior exposure (Krueger 2000). We entered this study with a hypothesis that teens, who are so familiar with technology, would embrace ADAS and not question its potential effectiveness (Gerrard et al 1996). Instead, teen participants were knowledgeable and opinionated, often skeptical of what they are told technology may offer. The majority of teens were in agreement that 1) ADAS should serve as a supplemental aid; 2) the ability to tailor the technology to personal preferences is important; and 3) ADAS has inherent value in the potential to bring greater safety to novice drivers in particular, and to all others on the road.

Limitations

Focus groups are effective in eliciting opinions and preferences and providing a snapshot of a participant group and are not generalizable to the greater population. These findings will guide researchers to areas for follow-up; themes will be further explored in a quantitative national survey.

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