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Video and Non-Video Feedback Interventions for Teen Drivers

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16 Abstract

In-vehicle feedback technologies, including some that use video, help parents monitor and mentor their young drivers. While different feedback technologies have been shown to reduce some risky driving behaviors, teens and parents cite privacy concerns as deterrents to using them, especially when the technologies use video. This study evaluated two similar technology-based interventions, one with video feedback and one without, to determine to what extent they reduced unsafe driving behaviors in newly licensed teen drivers relative to (a) a baseline period, and (b) a control group. Whether the video intervention produced a significantly different effect than the non-video intervention was also evaluated. The study enrolled two diverse cohorts of teen drivers: 32 from a rural site and 28 from a suburban site. Each was randomly assigned to the video feedback, the non-video feedback, or the control condition. A video event recorder installed in each teen's vehicle for 20 weeks recorded a 12-second video when the vehicle's lateral or longitudinal acceleration exceeded ±0.50g. All teens initially drove without feedback during a 4-week baseline segment. In the subsequent 16-week intervention phase, teens assigned to the intervention conditions received feedback. The number of unsafe driving events per 1,000 miles driven (event rate) for the intervention conditions significantly decreased over time and was 66% lower at the end of the study relative to the baseline segment. The event rate for the control condition did not change significantly over time and was about six times greater than the intervention condition. Event rates for the video and non-video feedback groups did not differ significantly. Both interventions reduced unsafe driving behaviors to a similar degree for two diverse groups of newly licensed teen drivers. One limitation of this study is that although feedback in the non-video condition did not contain any video-based information, the teens were aware that they were being video recorded. Future research should compare these findings to a feedback device that does not employ any video cameras.

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EXECUTIVE SUMMARY

Background

Young driver crash rates are very low when an adult supervisor is in the vehicle, but have been shown to increase about tenfold when teens begin driving independently (Mayhew, Simpson, & Pak, 2003). Several in-vehicle feedback technologies, including some that use video, help parents continue to monitor, mentor and instruct their teen drivers after they begin driving without supervision. Some of these interventions have shown success in reducing risky driving behaviors such as hard turning and braking (Carney, McGehee, Lee, Reyes, & Raby, 2010; McGehee, Carney, Raby, Reyes, & Lee, 2007; McGehee, Raby, Carney, Lee, & Reyes, 2007; Musicant & Lampel, 2010; Prato, Toledo, Lotan, & Taubman-Ben-Ari, 2010). However, teen drivers and their parents have cited privacy concerns and deterioration of trust as deterrents to using such technologies, especially those that involve video (Lerner et al., 2010; McCartt et al., 2007).

Objective

This study aimed to evaluate two similar technology-based interventions, one with video feedback and one without, to answer the following:

1. To what extent do two technology-based interventions, one including video feedback and one with non-video feedback, reduce unsafe driving behaviors of newly licensed teen drivers relative to (a) a baseline period and (b) a control group?
2. Does including video with the intervention produce a significantly different effect than a similar intervention without the video?

Methods

This study evaluated data from two diverse cohorts of teen drivers. The final analyses considered data from 32 teen drivers from eastern Iowa (the rural site; mean age at licensure 16 years 2 weeks and 80% had independent driving experience prior to licensure) and 28 teen drivers from Montgomery County, Maryland (the suburban site; mean age at licensure 16 years 49 weeks and no independent driving experience prior to licensure). A video event recorder installed in each teen's vehicle for 20 weeks recorded a 12-second video when the vehicle's lateral or longitudinal acceleration exceeded ±0.50g. Video coders analyzed the video events and classified them as: unsafe driving (coder observed unsafe behavior(s) that warranted feedback), an appropriate response (driver took the proper action in response to an external event), or invalid (event was not triggered by driver action and unsafe behaviors were not observed).

Each teen driver was randomly assigned to one of three conditions: (1) video feedback intervention, (2) non-video feedback intervention, or (3) control. During the first four weeks of data collection, the baseline segment, all teens drove without feedback. This was followed by an intervention phase of 16 weeks divided into 4-week segments. Participants assigned to the intervention conditions received feedback during this phase according to Table ES1 while the control group continued to drive without feedback. The rate of unsafe driving events per 1,000 miles driven (i.e., the event rate) was calculated based on the number of unsafe driving events and the total miles driven in each segment for each teen.

Table ES1. Feedback components included in each intervention condition

	Video feedback	Non- video feedback
LED flashes on ER during event and stays red after	X	X
Weekly report sent to parents	X	X
Number of events triggered	X	X
Type of events (e.g., hard braking, fast turn/curve)	X	X
Events with unbelted driver	X	X
Events with unbelted passengers present	X	
Events where a traffic violation occurred (e.g., running a stop sign)	X	
Descriptions of other unsafe driving events from invalid (i.e., rough surface) triggers	X	
CD with videos of events resulting from valid triggers	X	

Results

Relative to the baseline segment, the event rate for teens in the intervention conditions decreased over time. The average event rates during intervention segments 2, 3, and 4 (5.8, 4.8, and 4.9, respectively) were not significantly different from one another but were significantly lower than the rates during the baseline (14.2; $p < 0.001$ in all) and segment 1 (9.0; $p < 0.001$ in all). The rate during intervention segment 1 was also lower than the baseline ($p < 0.05$).

The event rate for participants in the control condition did not change significantly over time. During the intervention phase, teens in the control condition averaged about 35 unsafe events per 1000 miles driven. This was significantly greater than the intervention condition, $X^2 = 8.48$, $p < 0.01$, which had an average event rate of 6.1 during the intervention phase (see Figure ES1).

Event rates for the video and non-video feedback groups did not differ significantly, nor were there significant differences in the feedback components between these groups, i.e., rate of unsafe driving events due to valid triggers and rate of events due to invalid triggers (only the video group received feedback on the latter).

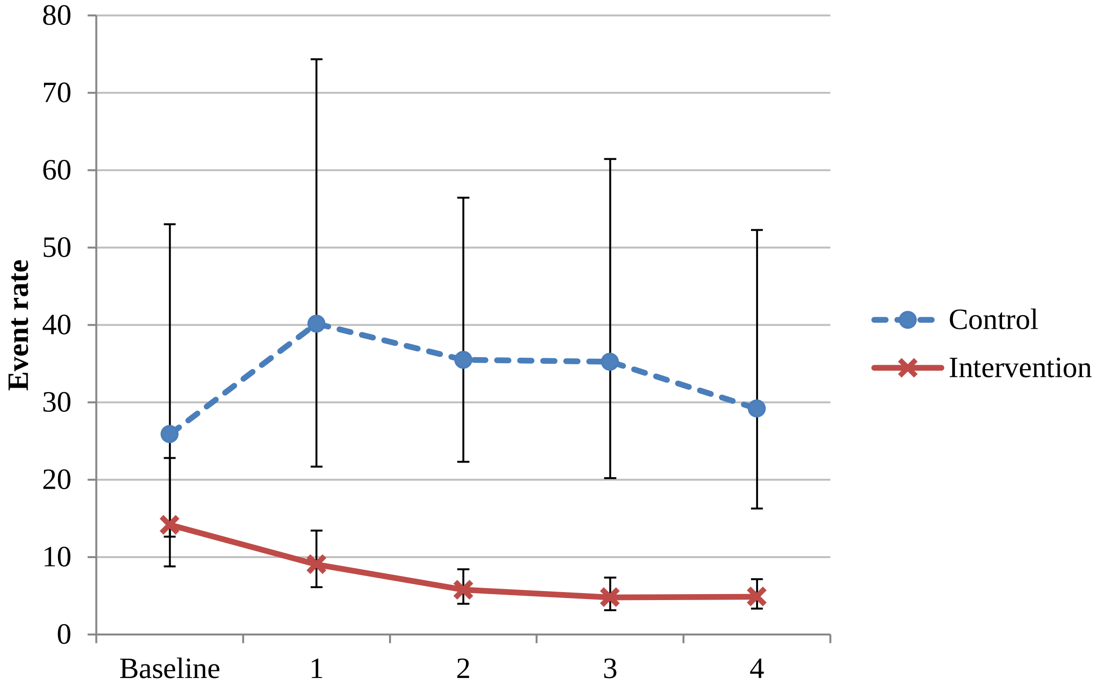

Figure ES1. Event rate (number of unsafe driving events per 1000 miles driven) over the five 4-week segments of the study: Baseline and Intervention segments 1, 2, 3, and 4 for the Control and Intervention conditions. Error bars indicate 95% confidence intervals for the least squares means.

Conclusions

This study found that both video feedback and non-video feedback interventions reduced unsafe driving behaviors to a similar degree for two diverse groups of newly licensed teen drivers. Teens in a control condition, who did not receive feedback, had event rates about six times greater than those in the intervention conditions.

INTRODUCTION

In the United States, obtaining a driver’s license is widely considered a teenage rite of passage. The first step to this milestone usually consists of obtaining a learner’s permit, which allows a young driver to operate a motor vehicle with adult supervision. Data show that crash rates during this period of adult-supervised practice are low, then increase about tenfold when young drivers begin to drive independently (Mayhew, Simpson, & Pak, 2003). Several in-vehicle technologies aim to help parents continue to monitor and instruct their teen drivers after they are driving on their own. Evaluations of these technology-based interventions have reported varying levels of success in reducing risky behaviors associated with abrupt braking, steering, and acceleration maneuvers as well as speeding and seatbelt nonuse (Carney, McGehee, Lee, Reyes, & Raby, 2010; Farmer, Kirley, & McCartt, 2010; McGehee, Carney, Raby, Reyes, & Lee, 2007; McGehee, Raby, Carney, Lee, & Reyes, 2007; Musicant & Lampel, 2010; Prato, Toledo, Lotan, & Taubman-Ben-Ari, 2010). Simons-Morton, Zhang, Jackson & Albert (2012) report risky driving behaviors characterized by high gravitational-forces predict subsequent near-crash events.

One intervention presented young drivers with video feedback about unsafe driving behaviors, including abrupt decelerations, accelerations, and steering maneuvers. Parents and teens received weekly reports with descriptions of unsafe driving events and the teen’s event frequency compared to other participants, along with a CD containing the videos of triggered events. McGehee et al. evaluated this intervention with two cohorts of newly licensed drivers. The number of unsafe driving events per 1,000 miles driven (event rate) was calculated for pre-intervention, intervention, and post-intervention phases. The first study enrolled 25 teens from rural Iowa (McGehee, Carney, et al., 2007; McGehee, Raby, et al., 2007). Compared to the pre-intervention phase, the average event rate was reduced by 58% in the first two months of intervention and by 76% during the third and fourth months. The second study, involving 36 teens from suburban Minneapolis, produced similar results (Carney et al., 2010). Both studies found that the intervention was particularly effective among the initially riskiest drivers.

Another evaluation (Farmer et al., 2010) employed a device that recorded sudden braking/acceleration, speeding, and seatbelt nonuse. This study enrolled 85 newly licensed teens in suburban Washington, DC. The protocol assigned drivers to one of four experimental conditions: (1) teens received immediate feedback and parents received prompt feedback online; (2) teens received immediate feedback, but were given a chance to correct behavior before it was posted online; (3) teens did not receive immediate feedback but parents received prompt feedback online; and (4) a control group that received no feedback. Teens in the study showed significant reductions in instances of speeding more than 10 mph over the limit only in condition 2, where the device gave teens an in-vehicle alert that parents would receive an e-mail report about the speeding incident, but teens believed they could cancel the report by correcting their behavior.

Evaluations of another non-video device were conducted in Israel (Prato et al., 2010) and in the United Kingdom (Musicant & Lampel, 2010). The device employed proprietary pattern recognition algorithms to identify risky driving maneuvers including speeding. When the system identified risky driving, a panel of three LEDs (green, yellow, and red) displayed immediate feedback to the driver, and families were provided with online access to view each driver's risk index. In Israel, families accessed online information 68.6% of the time. Modeling analyses revealed reduced risk among participants whose parents checked the online information (Prato et al., 2010). In the United Kingdom, overall event frequency (risky maneuvers per minutes of driving) decreased by 52%. The results of an analysis controlling for driving experience indicated the reduction in event frequency could be attributed to the availability of feedback (Musicant & Lampel, 2010).

These studies provide evidence that both video and non-video feedback can reduce the frequency of young drivers' unsafe behaviors. Though teens and parents have noted privacy concerns and deterioration of trust as the primary deterrents to installing monitoring devices (Lerner et al., 2010), parents reported being less likely to consider installing a device that uses video (McCartt, Hellinga, & Haire, 2007). Interestingly, the majority of teen drivers in the two studies conducted by McGehee et al. reported they did not consider the event recorder an invasion of privacy.

Research is needed to determine if the use of video is necessary to achieve the behavior changes seen in previous evaluation. Achieving comparable levels of behavior change without the use of video has clear cost implications for parents and designers of similar systems. The current study compared effects of similar interventions, one with video-based feedback and one without, on teens' driving behaviors.

Objectives

This study collected and analyzed data from two cohorts of newly licensed drivers, one rural and one suburban, to address the following research questions:

1. To what extent do two technology-based interventions, one including video feedback and one with non-video feedback, reduce unsafe driving behaviors of newly licensed teen drivers relative to (a) a baseline period, and (b) a control group?
2. Does including video with the intervention produce a significantly different effect than a similar intervention without the video?

METHODS

The final dataset included data from 68 teen drivers. About half the participants were from a rural site while the other half were from a suburban site. A video event recorder (ER) was installed in each teen's personal vehicle for 20 weeks. Each teen was randomly assigned to one of three conditions: control, video feedback intervention, or non-video feedback intervention. During the 4-week baseline segment, data were collected for all teens, but none received feedback. During the 16-week intervention phase, the participants assigned to the intervention conditions received feedback. The ER continued to collect data for the control group, but provided no feedback.

Instrumentation

Technicians mounted a DriveCam video ER (model DC3) on the inside of the windshield behind the rearview mirror (Figure 1) in each participant’s vehicle. This palm-size device had two video cameras, a three-axis accelerometer, a 12-second video data buffer, an infrared illuminator for lighting the vehicle’s interior at night, and a cellular transmitter. The device continuously buffered audio and video from both inside and outside the vehicle (see Figure **2**), but only wrote data to internal memory when the vehicle motion exceeded an acceleration threshold, typically due to abrupt steering or braking. Based on the guidance of the manufacturer and the threshold values used in another naturalistic driving study (Dingus et al., 2006), researchers set both lateral (side-to-side) and longitudinal (front-to-back) thresholds for this project at ±0.50g. Each video event captured the eight seconds before and four seconds after an event trigger. Event data and videos were encrypted and automatically uploaded daily to DriveCam’s fleet services server via a secure cellular connection. The research team viewed the event videos using password-protected DriveCam accounts online. In addition, custom software downloaded each event (.DCE) file and saved the event metadata in an SQL database on a dedicated computer at the University of Iowa.

Figure 1. DriveCam video event recorder

Figure 2. Exterior and interior video view captured by cameras on the DriveCam event recorder (image provided by DriveCam)

Experimental conditions

Prior to installation of the ER, researchers assigned participants to one of the three conditions (video feedback, no video-feedback, control) in randomized blocks of three within each gender. This ensured uniform enrollment among the three conditions throughout the study. Researchers informed participants of their group assignment during the last week of the baseline phase. During the intervention phase, participants assigned to one of the two intervention conditions received feedback, while those in the control condition continued to drive without feedback. Table 1 summarizes the feedback components for each experimental condition.

Table 1. Feedback components included in each experimental condition

	Video feedback	Non-video feedback
LED flashes on ER during event and stays red after	X	X
Weekly report sent to parents	X	X
Number of events triggered	X	X
Type of events (e.g., hard braking, fast turn/curve)	X	X
Events with unbelted driver	X	X
Events with unbelted passengers present	X	
Events where a traffic violation occurred (e.g., running a stop sign)	X	
Descriptions of other unsafe driving events from invalid (i.e., rough surface) triggers	X	

CD with videos of events resulting from valid triggers	X	

Participants in the video and non-video conditions received real-time feedback from an LED on the ER. Upon the first ignition start of the day and activation of the ER, the LED was green. When the vehicle motion triggered the ER, the LED flashed green and red for a few seconds and then remained red for the rest of that day.

Participants in both intervention groups received delayed feedback in the form of a weekly report sent to the participating parent. The specific content of the report depended on the intervention condition; Appendices A and B provide example reports for the feedback without and with video. The non-video group reports included the type of trigger (e.g., hard braking, fast turning, or excessive acceleration), event time, and location (if GPS data was available for that event). With the exception of driver seat belt use, the non-video reports did not contain any information that came from the video. Reports for the video group included information such as driver behaviors (e.g., talking on a cell phone), relevant environmental details (e.g., the teen was driving in a right-turn-only lane), and proximity to and actions of other vehicles (e.g., teen driver was following too closely). The report for the video group also included descriptions of any unsafe driving behaviors captured when the ER was triggered by something other than an unsafe driver action, for example, rolling through a stop sign just after a bump in the road triggered the ER. In addition, video-group reports tracked seat belt use for passengers riding in the vehicle. Participants in the video condition received a CD containing the driving video clips for the events triggered by driver action (either unsafe or appropriate response) for that week. The research team encouraged parents in both intervention groups to review reports (and videos) with their teen each week.

Participants

Recruitment efforts targeted parents of teens who were preparing to obtain a driver's license (see descriptions of recruitment strategies for each site below). Most teens enrolled in the study before obtaining a license, and all began data collection no later than 5 weeks after obtaining their intermediate license. Inclusion criteria required:

- a parent or guardian to enroll in the study with the teen;
- the teen be the primary driver of the instrumented vehicle (i.e., he/she drove the vehicle at least 80% of the time) and to average at least 90 minutes of driving per week; and
- parents and teens to be fluent in English and have access to a computer so they could view video events if assigned to the video feedback intervention group.

Researchers instructed parents interested in enrolling their teen drivers in the study to contact the study team for additional details and to confirm their teen's eligibility.

Each site planned to enroll 30 teens, with 5 male and 5 female drivers in each of the three experimental conditions, for a total of 60 participants. Difficulties with recruiting, data loss from malfunctioning ERs, and participants who were unable to complete the study resulted in unbalanced cells, as shown in Table 2. In total, the Iowa site enrolled 36 participants and had complete datasets for 32. The Maryland site enrolled 32 participants, had complete data for 25, and partial data for 3. Details about the participants who were unable to complete the study can be found in Appendix C.

Table 2. Participants included in data analyses by condition, gender, and site

Experimental condition	Gender	Rural (Iowa)	Suburban (Maryland)	Total
Control	Male	6	6	12
	Female	4	4	8
	Total	10	10	20
Non-video	Male	5	5	10
	Female	5	4	9
	Total	10	9	19
Video	Male	6	4	10
	Female	6	5	11
	Total	12	9	21
Total	Male	17	15	32
	Female	15	13	28
	Total	32	28	60

Rural site

In Iowa, teens can obtain an instruction permit at 14 years of age. After holding a permit for six months and completing a State-approved driver's education course, young drivers may, with school administrator approval, obtain a minor school license allowing them to drive between home, school, and extracurricular school activities. During the time this study was conducted, teens who turned 16 could obtain an intermediate driver's license if they had held a permit and maintained a clean driving record for six months. Thus, independent driving experience for teens obtaining an intermediate driver's license in Iowa can vary from none to 18 months or more.

The Iowa site team, with the assistance and support of administrators from 10 high schools within a 35-mile radius of Iowa City, mailed an information letter to the parents of teens who were between 15.5 and 15.75 years old. A study announcement also ran periodically in the daily newsletter at the University of Iowa hospitals and clinics. The Iowa site enrolled 36 participants who began data collection between the ages of 16 and 16.25 years (mean age 16 years 2 weeks); 80% had a minor school license before they obtained their intermediate license.

Suburban site

Driver's licensing requirements in Maryland differed significantly from those in Iowa, so study eligibility requirements also differed. In Maryland, teens cannot apply for a learner's permit until they are at least 15 years and 9 months; they are then required to hold the learner's permit for at least 9 months before they can apply for a driver's license. Teen participants at the Maryland site were between the ages of 16.5 years and 17.75 years (mean age 16 years 49 weeks) when they began the study.

The Maryland team directed recruitment efforts toward parents of teens planning to obtain a driver's license in 2012 or early 2013. Parent-Teacher Student Association (PTSA) representatives from six high schools within Montgomery County distributed the recruitment letter to parents on their LISTSERVs. The Maryland team also placed advertisements in a local newspaper, on Craigslist, on a community web forum, and on the Westat intranet site. The Maryland site enrolled 32 participants from Montgomery County, Maryland.

Procedure

Consent/assent procedure

About one month before the expected date of licensure, a member of the study team contacted the parent to schedule an information meeting with both the parent and teen to discuss the details of the study and review the informed consent document. These meetings typically lasted 20–30 minutes. If a family indicated they wanted to enroll in the study, the researcher obtained consent from the parent and assent from the teen.

Installation procedure

Technicians at a local Best Buy store installed the DriveCam systems in vehicles, with a member of the study team present. Installation (according to standard DriveCam procedures) took approximately 30–60 minutes per vehicle. One eligible family was excluded from the study due to incompatibility of the vehicle (a Saab 9-3) with the DriveCam system.

After installation, the researcher adjusted the angle of the interior-facing camera to ensure it captured a clear view of the study participant and any other vehicle occupants. To notify other occupants that they might be recorded, window clings were placed in the lower corner of the front passenger side window and both rear passenger side windows (Figure 3). For safety purposes, the researcher also checked the vehicle's seat belts for functionality. Researchers recorded the vehicle year, make, model, color, and license plate information for each participant, as well as the odometer reading. For teens who already had driver's licenses, this recording was the "starting" odometer reading. If installation occurred before the teen had a license, the family provided a "starting" odometer reading when the teen obtained their license and began driving independently.

NOTICE TO PASSENGERS

Figure 3. Window cling notifying occupants of video recording

Weekly text messages

Teen participants sent odometer readings by text message and/or e-mail once a week, on the same day on which data collection began. For example, participants who started data collection on a Monday sent odometer readings every Monday throughout the study. Researchers sent reminders via text message and/or e-mail (according to the participant's preference), and used the reading to calculate the teen's weekly mileage.

Video event coding

Video coders classified events triggered by participants into the categories shown in Table 3. At least two coders independently reviewed each event. A third coder made the final determination in the cases where there was disagreement. Events classified as either unsafe driving or appropriate responses were coded for a variety of variables describing:

- the nature of the event, its cause, and the number of vehicles involved;
- the driver action that caused the event (e.g., cornering or braking);
- driver seat belt use, the presence of loud music, and aggressive or reckless driving;
- the number, location, and age of passengers, and their seat belt use;
- environmental factors such as weather, lighting, road conditions, road geometry, and road type; and
- driver-related factors such as distraction, fatigue, and social influence of passengers.

Table 3. Classification of event types

Unsafe driving events	• *Incident*: An unsafe driver action triggered the ER

	• *Invalid trigger with safety concern:* Something other than an unsafe driving behavior triggered the ER (e.g., traveling over a rough or uneven surface), but reviewers observed a safety concern • *Near-crash:* the driver performed an evasive maneuver or the analysts observed another vehicle making an evasive maneuver to avoid a collision • *Crash:* a collision with an object or vehicle occurred while driving, cornering, or backing (coders classified contact with a curb while parking as an incident rather than a collision)
Appropriate response	• The driver took appropriate action in response to an external event that triggered the ER
Invalid events	• Something other than an unsafe driving behavior (e.g., traveling over a rough or uneven surface) triggered the ER and reviewers did not observe any safety concerns

Analysis of event data

The data analysis considered all events classified as unsafe driving, regardless of whether or not the event appeared in a report, and included valid triggers (i.e., incidents, near-crashes, and crashes) and invalid triggers where coders observed unsafe driving. The rate of unsafe driving events per 1,000 miles driven (i.e., the event rate) was calculated based on the number of unsafe driving events and the total miles driven in each segment for each teen.

The research team used Proc GENMOD in SAS 9.3 (Statistical Analysis System from the SAS Institute) for data analysis. The number of unsafe driving events in each segment was the dependent, repeated measure. The analyst used negative binomial regression models that included the log of the total miles each participant drove in each segment as the offset variable. Thus the effective dependent measure was the number of unsafe driving events per 1,000 miles driven. Finally, the negative binomial regression model included a statement that calculated influence statistics for each observation and for each participant (in SAS terms, a cluster).

RESULTS

Summary of event data

The event recorders captured a total of 5,675 events for the 60 teen drivers included in the analyses. Table 4 shows the number and percentage of events by event type. About 42% of the unsafe driving events were classified as incidents. Video coders observed safety concerns in just over 25% of the events recorded as the result of invalid triggers. These included rolling stops or running stop signs, using a cell phone, and unbelted occupants.

Table 4. Summary of unsafe driving events by event type

Event type	Number of events	Percent
Events recorded	5,675	100%
Unsafe driving (included in analysis)	3,332	58.7%
Incident	2,390	42.1%
Invalid trigger with safety concern	790	13.9%
Near-crash	84	1.5%
Crash	68	1.2%
Appropriate responses	69	1.2%
Invalid events	2,274	40.1%

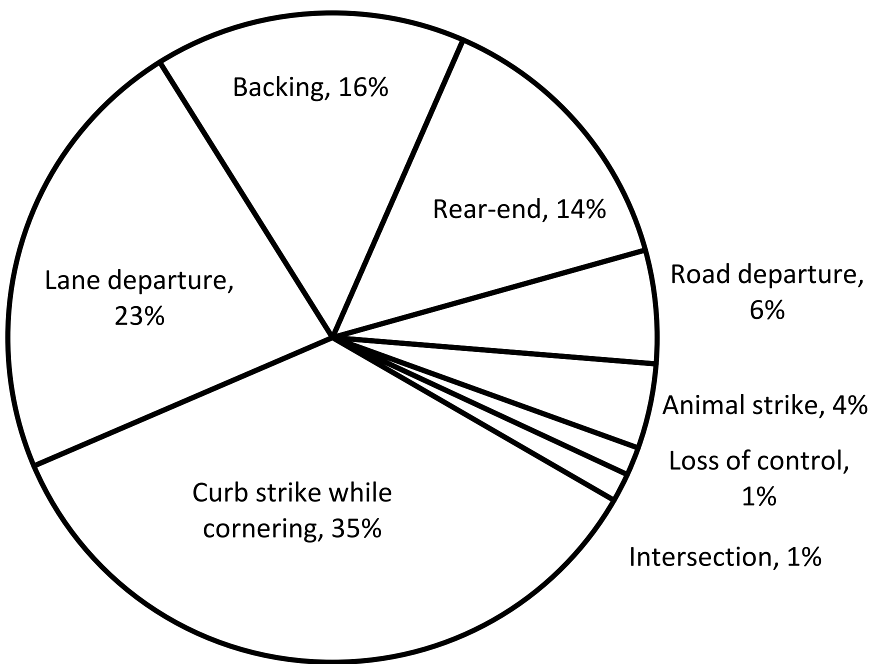

Figure 4. Crash type by percentage for 68 crash events

Effect of the intervention on unsafe driving events

These analyses sought to evaluate the extent to which the interventions reduced unsafe driving behaviors in newly licensed drivers relative to their own baseline driving and to a control group that did not receive any feedback.

Effect of interventions relative to baseline

When the data analyst initially examined the data from the intervention conditions, an outlier was discovered. One female participant from the suburban non-video group had the highest event rate in each segment of the study. This was due to a modest number of events but relatively low mileage. In the baseline segment, the rate was 647 events per 1,000 miles driven, a rate 26 times higher than the next-highest rate in the non-video group. For the intervention segments, the rates were 2.5 to 7 times higher. Influence statistics confirmed that this participant's data greatly affected parameter estimates in the statistical model (cluster Cook's D = 0.51; all other intervention participants had Cook's D values less than 0.10). The event rate for each segment for this participant was Winsorized, that is, the event count for each segment was adjusted downward such that the resulting event rate (event count over mileage) was adjacent to the next highest event rate (Tukey, 1962).

Analysis of the modified dataset found a significant effect of segment ($X^2 = 9.98$, $p < 0.05$) but no significant effects for site, intervention condition, or any interactions. Event rates for the intervention groups decreased during the intervention phase. While the average event rates for segments 2, 3, and 4 (5.8, 4.8, and 4.9, respectively) were not significantly different from one another, they all were significantly lower than the rates during the baseline segment (14.2; all $p < 0.001$) and intervention segment 1 (9.0; all $p < 0.001$). The rate during segment 1 was significantly lower than baseline ($p < 0.05$). These analyses were also conducted with the data for the outlying participant removed from the dataset; very similar results were found.

Effect of intervention relative to control

A second analysis evaluated the feedback intervention by comparing event rates of the teens who received feedback to those in the control group. Before conducting this analysis, the analyst examined event data from the control group for outliers. One male participant from the rural control group was identified as an outlier (cluster Cook's D = 0.57; all other control participants had cluster Cook's D values less than 0.15). Again, the outlying data point was Winsorized (Tukey, 1962). Analysis of the modified dataset from the control condition found no significant main effects for site or segment, or for their interaction.

Considering the data for the intervention segments with event rates modified for the aforementioned outliers, an analysis compared event rates of teens who received an intervention with those in the control condition. Participants in the control condition had a mean event rate of 35.3 during the intervention phase, significantly greater than the 6.1 unsafe driving events per 1,000 miles for teens who received feedback ($X^2 = 8.48$, $p < 0.01$; see Figure 5).

Role of video in intervention effectiveness

This study also aimed to determine whether providing video feedback differentially affected event rates compared to not providing such feedback. In addition to comparing the rate of all unsafe driving events for the video and non-video conditions, analyses considered the differences in the feedback components between these groups, i.e., rate of unsafe driving events due to valid and to invalid triggers (only the video group received feedback on the latter). We found no significant differences between the video and non-video group for any of the event rates. Figure 6 shows event rates for all unsafe driving events for both intervention groups at both sites.

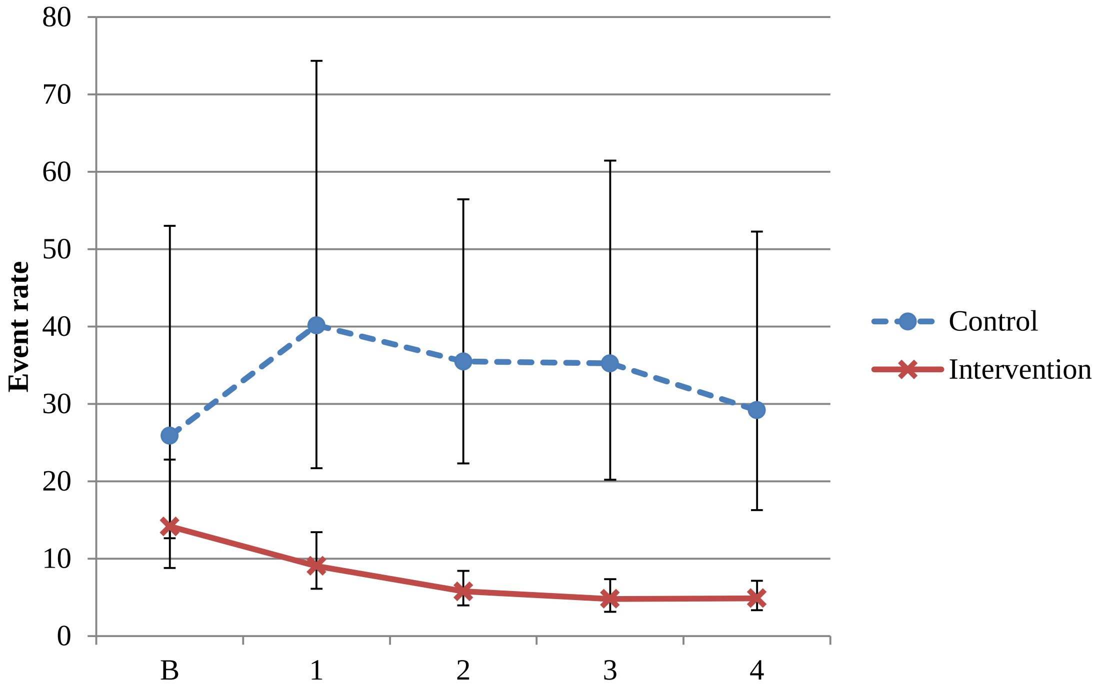

Figure 5. Event rate (number of unsafe driving events per 1,000 miles driven) over the five 4-week segments of the study: Baseline and Intervention segments 1, 2, 3, and 4 for the Control and Intervention conditions. Error bars indicate 95% confidence intervals for the least squares means.

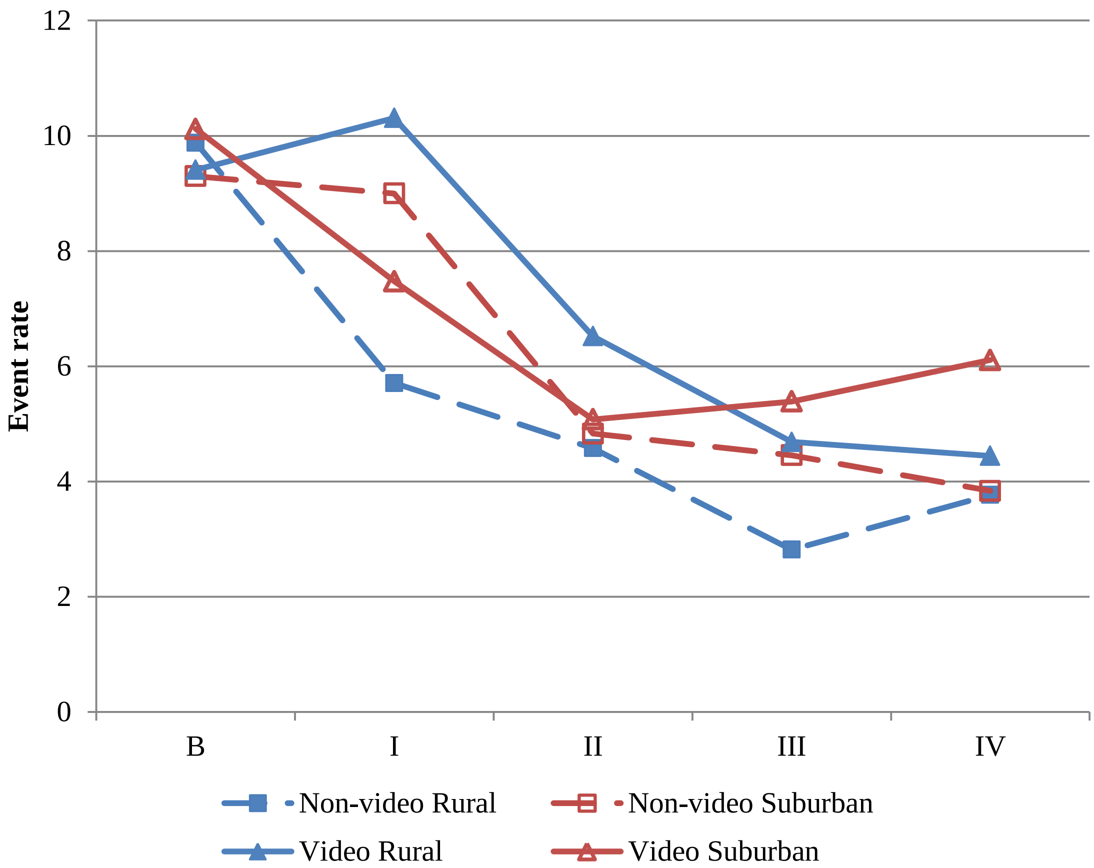

Figure 6. Event rate (number of unsafe driving events per 1,000 miles driven) over the five 4-week segments of the study: Baseline and Intervention segments 1, 2, 3, and 4 for Non-video and Video feedback by Rural and Suburban sites.

DISCUSSION

This study enrolled newly-licensed teen drivers from both rural and suburban sites. Due to licensing regulations at the two sites, teens from the rural site had an average age 10.5 months younger than those from the suburban site, and 80% had some earlier independent driving experience with a minor school license. Despite these differences, the effects of providing feedback were robust; teen drivers from both sites who were provided with feedback about their unsafe driving behaviors had reduced rates of unsafe driving events relative to the baseline period before feedback began.

Teen drivers in the control condition who did not receive feedback about their unsafe driving behaviors had an average event rate six times greater than the teens who received feedback. The event rate for the teens in the control group did not change significantly over the course of the study; if there had been an effect of maturation, we would expect the rate of unsafe behaviors to decrease as the teen drivers gained driving experience. To the contrary, though the increase was not statistically significant, the event rate increased from about 26 events per 1,000 miles in the baseline phase to about 40 in the first segment of the intervention phase (refer to Figure 5).

This study evaluated two technology-based interventions for teen drivers that employed two different kinds of feedback about unsafe driving for teen drivers. The event descriptions on the weekly reports for the video feedback condition included both unsafe behaviors and appropriate responses observed in the videos for events with both valid (event recorder was triggered due to unsafe or appropriate driver action) and invalid (not due to driver action) triggers. In addition the video clips for the events due to valid triggers were sent on a disc with the report. The weekly report for the non-video feedback condition contained only information that could be gleaned from the event metadata without the video (the one exception being driver seat belt use). Even after considering the differences in the type of events included in the weekly report for the video and non-video feedback groups, we found no significant differences in event rates for the two groups. This result should be viewed with caution, however, and may not be applicable to all feedback interventions that do not employ video. Although the teen drivers in the non-video condition received feedback independent of the context provided by video, they were well aware that when the event recorder was triggered their driving behaviors were captured on video and that the video events were being regularly reviewed by researchers. The effect of the presence of an active video event recorder on driver behavior as compared to a so-called “black box” feedback system that does not capture video remains unknown. It is also unknown how feedback provided in a the form of a physical report mailed to the parents may or may not have facilitated parental monitoring and instruction to the teen drivers, and whether or not the presence or absence of video information in the reports made a difference in parent-teen interactions.

Limitations

There are a number of considerations that limit the generalizability of these findings to the wider population of teen drivers. Teens who are willing to have a video ER installed in their vehicle and complete the study procedures may not be representative of all newly licensed teen drivers. Similarly, not all parents are willing to have a video ER in their teen’s vehicle (Lerner et al., 2010; McCartt et al., 2007). In order to be eligible for the study, the teen had to be the primary driver of a vehicle, which excludes families who do not have the financial resources to procure, insure, and maintain a vehicle for the teen’s use. Research has shown that teens who share vehicles with other family member have fewer crashes (Klauer, Simons-Morton, Lee, et al., 2011) so this study could potentially demonstrate bigger effects here than one might observe in the general population of teen drivers. Finally, nearly all the teens in this study obtained driver’s licenses almost immediately after they were eligible for them. Anecdotal evidence suggests that not all teen drivers are eager to begin driving and many decide to wait until they are older.

Crashes and near-crashes are relatively infrequent, so these analyses were based on the assumption that the measure we used, number of events with unsafe driving per 1,000 miles, was representative of crash rates, and that lowering the rate of these events would result in a decrease in actual crash risk. Simons-Morton, Zhang, Jackson & Albert (2012) found that instances of driving characterized by high gravitational forces were predictive of near-crashes.

CONCLUSIONS

This study found that both video and non-video feedback interventions reduced unsafe driving behaviors to a similar degree for two diverse groups of newly licensed teen drivers. Teens in a control condition that did not receive feedback had event rates about six times higher than those in the intervention condition. Future research should examine the effect of a feedback system that does not employ video recording as well as the feedback methods employed (i.e., online access or mailed reports for parents), and whether parents and teens feel these features aid or hinder communication about safe driving.

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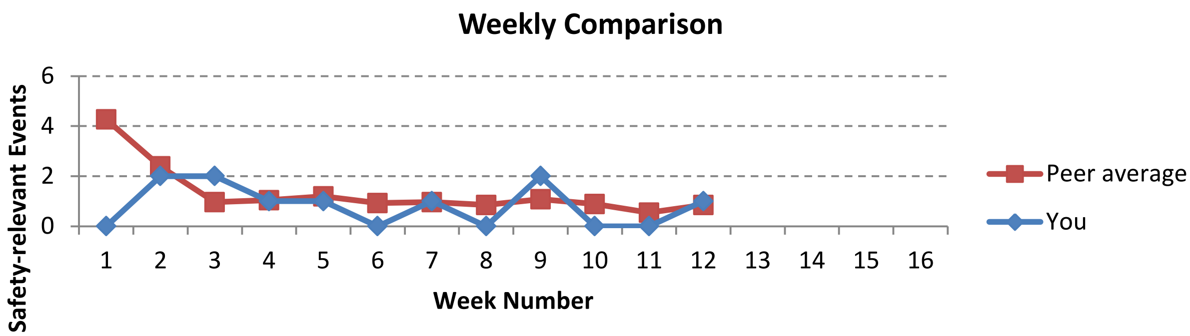
APPENDIX A. EXAMPLE OF NON-VIDEO WEEKLY REPORT (IOWA SITE)

The University of Iowa

Teen Driving Study Weekly Report

Driver NonVideo Participant

Week Week 12 – Tuesday, April 10 to Monday, April 16, 2012



Safety-relevant events this week:

1. Event 86542– Driver brakes hard on S. First Ave just northeast of intersection with Lower Muscatine Road (April 13 3:35 PM)

Seatbelt use for driver: 100% (1/1)

Goals for next week
Make sure you are always scanning ahead for changing traffic conditions and lights; be ready to stop.

Driving tip of the week: Make the task of driving your top priority. When we assume our driving "duties," one of the most important is that we be responsible for our actions and the results of those actions. In almost every case, a driver involved in a collision had an opportunity to avoid the collision—even when the other driver was responsible for the errors that led to the collision. Some of the most common driving distractions are: eating, drinking, applying make-up, talking on cell phones, adjusting the radio or changing CD's, dealing with rambunctious or misbehaving kids, or even just talking to passengers. Some drivers focus on single tasks (looking for an address, for example) and neglect all others. You can help make the road much safer for yourself, your passengers, and the others around you if you make a habit of keeping the driving task as JOB ONE, and let someone else do the map reading or change the radio station! It's important to recognize your distractions—and make conscious efforts to minimize or avoid them.

Important Information
Don't forget to give your weekly odometer reading every Tuesday. If you have any questions, please do not hesitate to contact us at [redacted] or email at [redacted].

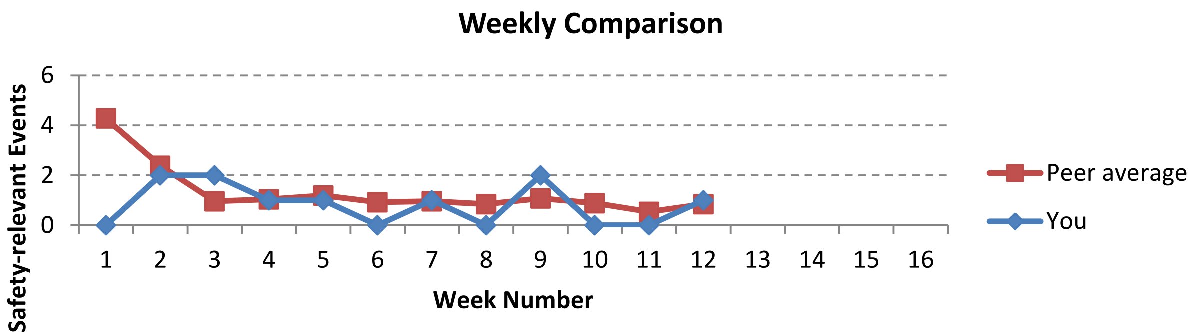
APPENDIX B. EXAMPLE OF VIDEO WEEKLY REPORT (IOWA SITE)

THE UNIVERSITY OF IOWA

Teen Driving Study Weekly Report

Driver Video Participant

Week Week 12 – Tuesday, April 10 to Monday, April 16, 2012



Safety-relevant video events this week:

1. Event 86542– Driver is following at 1.5 seconds and is distracted by conversation with a passenger; has to brake hard for lead vehicle on S. First Ave just northeast of intersection with Lower Muscatine Road (April 13 3:35 PM)

Other safety-relevant events recorded:

1. Driver is using cell phone

Seatbelt use for driver: 100% (2/2)
Seatbelt use of passengers: 100% (2/2)

Goals for next week

Never use your cell phone while driving. Take care not to follow too closely. Maintaining a following distance of 3-4 seconds between you and the vehicle in front of you will give you enough time and room to react to most situations and avoid a collision. Remember to maintain your full focus on the road at all times.

Driving tip of the week: Make the task of driving your top priority. When we assume our driving "duties," one of the most important is that we be responsible for our actions and the results of those actions. In almost every case, a driver involved in a collision had an opportunity to avoid the collision—even when the other driver was responsible for the errors that led to the collision. Some of the most common driving distractions are: eating, drinking, applying make-up, talking on cell phones, adjusting the radio or changing CD's, dealing with rambunctious or misbehaving kids, or even just talking to passengers. Some drivers focus on single tasks (looking for an address, for example) and neglect all others. You can help make the road much safer for yourself, your passengers, and the others around you if you make a habit of keeping the driving task as JOB ONE, and let someone else do the map reading or change the radio station! It's important to recognize your distractions—and make conscious efforts to minimize or avoid them.

Important Information
Don’t forget to give your weekly odometer reading every Tuesday. If you have any questions, please do not hesitate to contact us at [redacted] or email at [redacted].

APPENDIX C: REASONS ENROLLED PARTICIPANTS WERE UNABLE TO COMPLETE THE STUDY

Site	Condition	Time in Study	Reason participant was unable to complete the study
Maryland	C	0 weeks	Vehicle (e.g., Saab 9-3) was not compatible with the DriveCam device.
Maryland	N/A	0 weeks	Family became ineligible. Teen participant was not the primary driver of the vehicle.
Iowa	C	20 weeks	Data downloads from DriveCam to the UI server had failed to capture all the data from the first few weeks of this teen’s participation.
Iowa	C	3 weeks	Teen participant had a road departure crash (no injuries), vehicle was undrivable and participant did not resume data collection when she began driving again.
Iowa	C	6 weeks	Teen participant had an intersection crash (possible injuries); family opted to leave study so they could receive crash report and video.
Iowa	N	9 weeks	Teen was no longer going to be driving regularly and had to leave the study.
Maryland	V	20 weeks	Data downloads from DriveCam to the UI server had failed to capture all the data from the first few weeks of this teen’s participation.
Maryland	N	20 weeks	Data downloads from DriveCam to the UI server had failed to capture all the data from the first few weeks of this teen’s participation.
Maryland	C	20 weeks	Data downloads from DriveCam to the UI server had failed to capture all the data from the first few weeks of this teen’s participation.
Maryland	V	20 weeks	DriveCam device failed to upload data throughout entire study, participant received invalid feedback reports.
Maryland	*C	20 weeks	DriveCam device failed to upload data throughout entire study, 14 weeks of data recovered.
Maryland	*V	15 weeks	Participant was asked to leave the study for safety reasons, team observed dangerous driving during angry episodes directed at the event recorder.
Maryland	*N	17 weeks	Excessive break from driving the vehicle with the event recorder due to vacation, then had car problem.

* Data for these participants were included in the analyses

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