INCREASING SEAT BELT USE IN SERVICE VEHICLE DRIVERS WITH A GEARSHIFT DELAY

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This study evaluated a device that prevents drivers from shifting vehicles into gear for up to 8 s unless seat belts are buckled. Participants were 101 commercial drivers who operated vans, pickups, or other light trucks from the U.S. and Canada. The driver could escape or avoid the delay by fastening his or her seat belt before shifting out of park. Unbelted participants experienced either a constant delay (8 s) or a variable delay (M = 8 s). A 16-s delay was introduced for those U.S. drivers who did not show significant improvement. Seat belt use increased from 48% to 67% (a 40% increase) for U.S. drivers and from 54% to 74% (a 37% increase) for Canadian drivers. The fixed delay was more effective for U.S. drivers than the variable delay, but there was no difference between these two delay schedules for Canadian drivers. After the driver fastened his or her seat belt, it tended to remain fastened for the duration of the trip.

Key words: automated consequences, gearshift delay, negative reinforcement, seat belt use

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Wearing a seat belt has been shown to be effective in avoiding serious injury in traffic accidents (Tison et al., 2008). Existing efforts to increase seat belt use have focused primarily on public education, high-visibility police enforcement, and seat belt reminder systems (Cox & Geller, 2010). Although seat belt use rates in the U.S. increased from less than 60% in 1994 to 83% in 2008 (National Highway Traffic Safety Administration [NHTSA], 2008), a substantial number of drivers still drive unbelted.

Behavioral interventions that combine enforcement and education campaigns have been associated with increases in seat belt use in the

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U.S. and Canada. NHTSA's Click It or Ticket high-visibility enforcement model has raised levels of seat belt use to above 80% in the U.S. and has been successful particularly in states with primary seat belt laws (i.e., states in which police can issue a citation to a driver if the only violation is noncompliance with the seat belt law; Jonah & Grant, 1985; Williams, Reinfurt, & Wells, 1996). The approach influences behavior via the threat of direct punishment in the form of a fine that may result in rule-governed behavior (e.g., "If I don't wear my seat belt, I may have to pay a fine"). High-visibility enforcement can strengthen the rule when drivers see or hear about seat belt enforcement operations. The model requires substantial efforts in terms of both funding and police time. As a result, there has been renewed interest in evaluating vehicle-engineered solutions to increase seat belt use.

Reminder systems were the original engineering solution to improve seat belt use. Most reminder systems focus exclusively on drivers rather than passengers. The standard reminders combine a visual icon that lasts for up to 60 s and an auditory warning that lasts between 4 and 8 s. Malenfant and Van Houten (2008) provided evidence that the U.S. regulations resulted in modifications that compromised the saliency of the signal. For example, if the prompt occurs after the driver starts the car, but before he or she scrapes the windshield in the winter, the signal will have terminated long before the driver has the opportunity to fasten his or her seat belt. Designers might optimize the effectiveness of the buckling prompt by activating the reminder after the driver has ample opportunity to buckle up without the prompt (e.g., approximately 30 s after the driver places the vehicle in gear). Only those drivers least likely to buckle up would experience such a reminder. In recent years, auto manufacturers have introduced enhanced seat belt reminders that present warning tones or display visual icons if the driver's seat belt is not fastened after he or she has begun to drive. NHTSA (2009) documented that these enhanced reminders are associated with a significant increase in seat belt use. Although enhanced reminder systems are associated with increased seat belt use, they still are not effective with drivers with low levels or inconsistent use.

A more direct approach to increase seat belt use involves the application of an ignition interlock system that prevents the operator from using the vehicle when the seat belt is not buckled. These systems were introduced in the 1970s. To the extent that drivers could not bypass or defeat such a system, seat belt use should increase to 100%. Unfortunately, there are ways to defeat or deactivate these systems. For example, Geller, Casali, and Johnson (1980) observed 1,579 cars entering or exiting campus parking lots and found that 62% of vehicles with working interlocks or unlimited buzzer reminder systems had these safety systems deactivated. Only 16% of drivers of vehicles with defeated or deactivated systems wore their seat belts. Based on these data and public uproar, these ignition interlock systems were abandoned (see Parasuraman & Riley, 1997).

There are two reasons why these systems encountered such strong public resistance. First, baseline seat belt use was very low when the system was mandated, and public support for seat belt use was not very high. Second, a seat belt–ignition interlock is associated with a number of practical problems. For example, an interlock would not allow a driver to use a remote start device, and they require the operator to buckle up before starting the vehicle to cool it down in the summer or warm it up in the winter.

An alternative interlock system that requires belting prior to placing the vehicle into drive would avoid many of these problems. Van Houten, Malenfant, Austin, and Lebbon (2005) demonstrated that imposing a short delay before allowing a driver to shift from park when the seat belt is not fastened was effective in increasing seat belt use. Specifically, fixed delays of 5 to 20 s increased mean seat belt use from 45% to 81%. However, feedback from the drivers in the study indicated that 20-s fixed delays were aversive to the point that some of the drivers attempted to circumvent the system.

The number of complaints increased when the participants were required to buckle up for even very short trips. The drivers in Van Houten et al. (2005) suggested that a modification to allow regularly buckled drivers to avoid the gearshift delay for short trips (e.g., moving to a different parking space) would increase driver acceptability. In addition, two drivers indicated that they typically buckled after placing their vehicle in motion. They suggested that researchers count trips in which drivers buckled within a few seconds after putting the vehicle into motion as buckled trips. These two buckling patterns represented nearly 25% of all drivers (Malenfant & Van Houten, 2008).

The purpose of the current study was to evaluate the efficacy of a gearshift delay contingent on low seat belt use on the seat belt use of a large sample of service vehicle drivers.

METHOD

Participants

The efficiency of the seat belt gearshift system was field tested with a fleet of 60 U.S. and 60 Canadian vehicles from both government agencies and the private sector. The city of St. Petersburg, Florida, allowed 60 of their vehicle fleet to be modified for this study, which represented the U.S. vehicle sample. Drivers from the U.S. sample were adult males who made a mean of 15 trips per day. The participating Canadian agencies included the New Brunswick Power Commission, the city of Moncton, the city of Dieppe, Plexus Canada, Radio-Canada, and the Halifax Regional Municipality. One female and 59 male drivers comprised the Canadian sample. Data from 10 vehicles from the U.S. sample were excluded from analysis for the following reasons: circumvention of the delay system by briefly depressing the seat belt release button (seven drivers), leaving the vehicle in neutral with the engine running and the emergency brake on (one driver), disconnection of the device (one driver), and hardware failure after installation (one driver). Data from five of the Canadian vehicles were not used due to equipment malfunction. Drivers of three other vehicles failed to bring their vehicles in for downloads and to switch on the device. Data from two vehicles were omitted because baseline data were not collected. Thus, data from 50 U.S. vehicles and 51 Canadian vehicles are reported. Vehicles included quarter-ton and half-ton GMC, Chevrolet, or Ford trucks and GMC or Chevrolet vans ranging from 1998- to 2005-year models. Most drivers drove the same vehicle throughout the study.

The researchers assured participating agencies and drivers that individual seat belt use data would be kept anonymous and confidential. Each employer fully agreed and supported this commitment.

Apparatus

The apparatus included a data logger installed under the driver's seat that was connected to seven functions of the vehicle via a specially designed harness, as well as a chime and seat sensor. This microprocessor recorded data and included a programmable gearshift delay plus seat belt reminder. Researchers could select the absence of a delay for baseline recording, an 8-s fixed delay, an 8-s variable delay, a 16-s fixed delay, or a 16-s variable delay. The U.S. sample included 26 vehicles with a fixed delay and 24 vehicles with a variable delay. The Canadian sample included 26 vehicles with a fixed delay and 25 vehicles with a variable delay.

The gearshift delay activated when an unbuckled driver depressed the brake pedal. Drivers had the option of buckling, which immediately terminated the delay (negative reinforcement), or waiting out the delay. To prevent drivers from bypassing the device by buckling the seat belt before entering the vehicle, the delay and chime activated if the seat belt was buckled before the driver sat down.

Trips began when vehicles were in motion for more than 30 s. *End of trip* was defined by either of two independent criteria. The first was simultaneous absence of vehicle motion and weight on the seat sensor for more than 10 s. We adopted this definition to discourage drivers from avoiding the delay by leaving the motor running between trips, which would be potentially unsafe. Second, the ignition had to be off for more than 180 s. This threshold was set high to ensure drivers with stalled vehicles in dangerous locations such as railroad crossings could restart and place vehicles in gear if their seat belts were unfastened. We reasoned that it was unlikely that drivers would turn the vehicle off for periods less than 180 s before attempting a restart. Participants who were belted during at least 80% of trips lasting more than 30 s avoided the delay altogether. Figure 1 shows the decision tree for the program to modify the delay given the behavior of the driver over the last 10 trips.

Data Collection

The data logger recorded duration of motion, presence of weight on the driver seat, ignition on or off, brake on or off, seat belt delay on or off, seat belt on or off, start of trip, end of trip, and trip history in baseline and experimental conditions. Each of these events was recorded with a date and time stamp. In addition, the microprocessor was capable of analyzing the recorded data and downloading data into a spreadsheet. The program calculated the percentage of belted trips and the times when the seat belt was unbuckled for more then 15 s after the vehicle began moving. The research programmer selected the gearshift delay conditions and downloaded dependent measures by connecting a laptop computer to the data logger. Onset and offset of the warning chimes coincided with the preset gearshift delay.

The dependent variables in this study were percentage of belted trips (the number of belted trips divided by the total number of trips, which was converted to a percentage), percentage of trips the driver removed the seat belt (the number of trips the driver removed the seat belt divided by the total number of trips, which was converted to a percentage), percentage of trips with no delay (the number of trips with no delay divided by the total number of trips, which was converted to a percentage), mean number of trips per day, and mean trip duration. The independent variables were delay type (fixed or variable) and delay interval (8 or 16 s).

Experimental Design

An A-B-A reversal design was used for the study. Because the system was activated at a different point in time for each participant as a result of having only limited access to the vehicles to modify the program, a multiple baseline across individuals was also used.

Procedure

Prior to installing and recording data, meetings were held with the drivers, their union representatives, and their supervisors to inform them that data loggers had been placed in their vehicles as part of a study for the NHTSA and Transport Canada. The experimenter told drivers about the interventions prior to activating the gearshift delay and provided drivers with printed summaries describing each phase of the study.

The duration of each phase was based on the researcher's ability to access the vehicles. Because vehicle downloads could be scheduled only a fixed number of times without inconveniencing the fleets, it was not possible to schedule equal treatment duration periods for each vehicle or to use stability of the data as the criterion for changing phases.

Baseline. The data loggers were installed, and baseline data collection began. The loggers

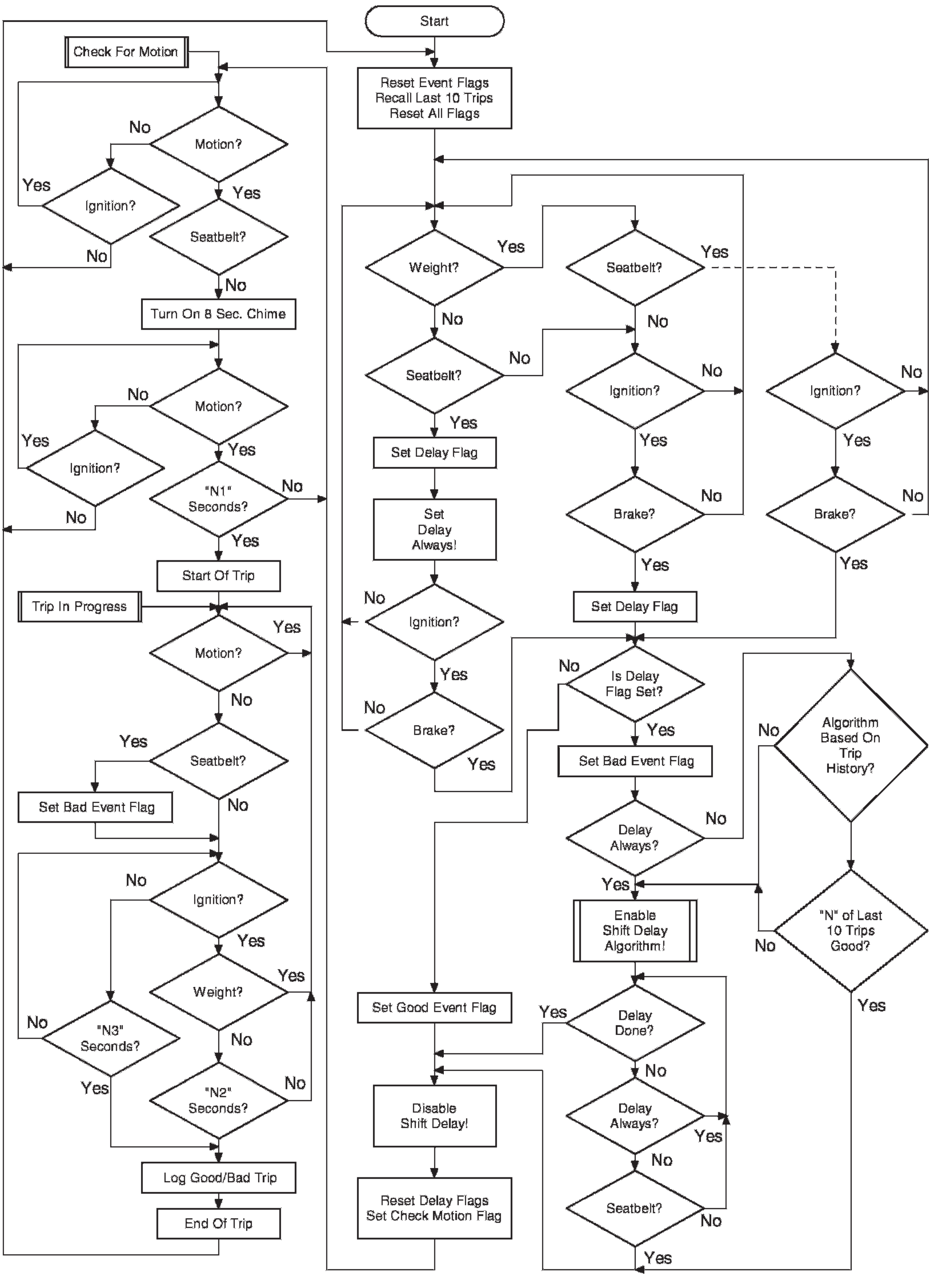

Figure 1. The decision tree used to describe the set of rules used by the data logger to set the delay.

Table 1
Mean Percentage of Time U.S. Drivers Used Seat Belts During the Study

Vehicle	Baseline	8-s fixed delay	16-s fixed delay	8-s fixed delay	Baseline 2	Vehicle	Baseline	8-s variable delay	16-s variable delay	Baseline 2
1	72	90	89			1	12	83	81	
2	34	79			2	2	86	83		67
3	50	86	83	80		3	91	19	29	
4	40	5	10		100	4	87	90	94	94
5	82	44				5	82	86		71
6	13	4				6	69	75	77	73
7	21	84			60	7	69	83		77
8	55	90			93	8	48	71	83	62
9	15	92			94	9	93	99		98
10	4	52	31		8	10	64	43	39	72
11	86	97			87	11	29	66	61	32
12	87	93			61	12	0	1	3	3
13	53	80			63	13	32	74		24
14	38	51	75		12	14	8	6	0	21
15	41	88			86	15	84	92		21
16	2	46	43		32	16	31	38	41	
17	27	49	69			17	33	39	58	17
18	83	88	87		84	18	44	42	56	37
19	94	90	98		99	19	80	95		74
20	11	57			81	20	56	72		9
21	50	76			26	21	69	90	83	89
22	11	93				22	26	28		21
23	27	90			100	23	53	88		94
24	45	63	71		51	24	59	93	85	34
25	32	95	97		76					
26	10	33	42		17					
Mean	41.7	69.8			61.6		54.4	64.8		51.9

recorded the dependent measures, but drivers did not experience the seat belt-gearshift delay. For the U.S. sample, the initial baseline period ranged from 4 to 52 days (M = 24.6, SD = 7.97). For the Canadian sample, the range was 3 to 66 days (M = 18.4, SD = 11.1).

Gearshift intervention. After obtaining baseline data from all vehicle fleets, half the vehicles were assigned randomly to receive a fixed (8 s) or variable (M = 8 s; range, 4 to 19 s) gearshift delay. If the response to the 8-s delay did not produce marked improvements in seat belt use, the interval was increased to a 16-s delay for U.S. vehicles. For the U.S. sample, the intervention phase lasted 12 to 103 days (M = 37.3, SD = 20.3). For the Canadian sample, the intervention phase lasted 10 to 89 days (M = 41.9, SD = 19.8).

Return to baseline. The seat belt delay with its associated reminder was inactive during the return to baseline while data continued to be logged. For the U.S. sample, the second baseline period ranged from 4 to 43 days (M = 27.1, SD = 8.0). For the Canadian sample, the second baseline lasted 6 to 42 days (M = 24.6, SD = 9.0). At the end of the study, the data loggers were removed from all vehicles.

Focus Group

After data collection was completed, the researchers met with the group of drivers to obtain feedback on the gearshift delay systems. Topics of interest included perceived system effectiveness, ability to bypass, usefulness for teenage drivers, annoyance, and acceptance of gearshift delay.

RESULTS

Table 1 shows the percentage of time individual U.S. drivers used seat belts in the fixed- and variable-delay conditions and the

Table 2
Mean Percentage of Time Canadian Drivers Used Their Seat Belts During the Study

Vehicle	Baseline	8-s fixed delay	Baseline 2	Vehicle	Baseline	8-s variable delay	Baseline 2
1	39	81	27	1	40	54	28
2	83	93	95	2	71	85	81
3	17	76	56	3	13	17	43
4	63	88	92	4	66	79	75
5	88	70	6	5	59	78	26
6	97	83	69	6	74	87	82
7	4	13	9	7	82	94	83
8	93	98	93	8	67	76	45
9	39	73	34	9	82	97	87
10	46	67	56	10	54	72	72
11	82	86	81	11	62	78	67
12	27	84	89	12	21	74	49
13	10	74	19	13	67	95	95
14	93	93	99	14	69	72	69
15	61	78	69	15	35	81	
16	63	41		16	67	82	84
17	55	89	88	17	85	97	100
18	82	72	67	18	64	87	74
19	5.2	59		19	50	87	84
20	4	14	2.7	20	97	79	
21	86	82	95	21	89	85	
22	5	83		22	13	53	
23		26	48	23	3	72	
24		82	76	24	11	53	
25		90	83	25		80	36
26		86	50				
Mean	51.9	72.3	61		55.9	76.6	67.4

group means for each phase. There was considerable variation among the overall sample with regard to the effect of the intervention and its maintenance after removal. For many drivers, the treatment was effective only during the intervention period. By contrast, some drivers increased the frequency with which they drove buckled and maintained this frequency during the return to baseline. The sample also included some drivers whose seat belt use was low regardless of condition. Overall, mean seat belt use was higher during the 8-s delay treatment than baseline for 84% of drivers.

A portion of the U.S. sample experienced a 16-s gearshift delay phase after exposure to the 8-s delay. Twelve of 26 participants assigned to the fixed delay received the 16-s delay, and 14 of 24 participants in the variable delay received this longer intervention. Difference scores were generated by subtracting the mean percentage of seat belt use during each intervention condition (16- and 8-s delays) from mean percentage of use during baseline. We then conducted two *t* tests, one for participants in the fixed delay and one for participants in the variable delay, to determine if there was a difference between the 8- and 16-s delays. Neither the *t* test for the fixed-delay condition nor that for the variable-delay condition was significant, $t(24) = 1.62$, *ns*, $t(22) = .41$, *ns*, respectively. Mean percentage of seat belt use did not vary reliably between individuals who received the 8-s delay or the 16-s delay.

Table 2 shows the percentage of time individual Canadian drivers used seat belts in the fixed- and variable-delay conditions and the group means for each phase. Again, there was considerable variability in the individual data, with 42 of the 51 drivers showing higher mean seat belt use during the treatment condition. It should be noted that the baseline data were lost for five Canadian drivers. In these cases, treatment was compared to the return to baseline.

Table 3
Mean Percentage (and *SD*) of Trips Wearing a Seat Belt

	Baseline	Intervention	Return to baseline
United States			
Fixed	41.65 (28.21)	69.85 (27.11)*	61.60 (33.91)
Variable	54.37 (27.94)	64.83 (29.86)*	51.91 (31.42)
Canada			
Fixed	51.92 (33.75)	72.35 (23.38)*	61.03 (31.37)
Variable	55.88 (26.98)	76.56 (17.40)*	67.37 (22.63)

* $p = .01$.

Table 3 presents the means and standard deviations for these variables as a function of treatment period and country. Significant differences between conditions are marked with an asterisk. A 2 (Country) × 2 (Delay Type) × 3 (Treatment Condition) mixed analysis of variance (ANOVA) was conducted to evaluate differences in seat belt use using SPSS. The main effect for country was significant, $F(1, 268) = 4.1, p < .05$. Across treatment condition and delay type, Canadian participants drove a significantly higher percentage of belted trips ($M = 65\%$) than their U.S. counterparts ($M = 57\%$). A similar 2 × 2 × 3 ANOVA tested for differences in trip duration. The main effect for country was significant, $F(1, 229) = 25.6, p < .001$. The Canadian sample drove longer trips ($M = 11.4$ min) than the U.S. sample ($M = 8.6$ min).

As a result of this difference between countries, separate 2 (Delay Type) × 3 (Treatment Condition) ANOVAs assessed each sample for the effect of delay type on the mean percentage of buckled trips. For this analysis, mean belt use for the intervention period was defined as the usage rate during exposure to the 8-s delay. As expected, there was a main effect for treatment condition, $F(2, 135) = 5.3, p < .01$, for the U.S. sample. A Tukey HSD post-hoc test revealed that the mean percentage of belt use was significantly higher during the intervention period when drivers drove with the delay ($M = 67\%$) than during the first baseline period ($M = 48\%$). The main effect for delay type was not significant, $F(1, 135) = .02$, *ns*. The interaction between delay type and treatment condition also was not significant, $F(2, 135) = 1.9$, *ns*.

The pattern of results for the Canadian sample was similar to the U.S. sample. As expected, the main effect for treatment condition was significant, $F(2, 133) = 7.4, p < .01$. A Tukey HSD post-hoc test indicated that the Canadian drivers wore their seat belts more frequently during the intervention period ($M = 74\%$) than the initial baseline phase. As with the U.S. sample, the effects for delay type and the delay type by treatment condition interaction were not significant, $F(1, 135) = 0.02$, *ns*, and $F(2, 135) = 1.9$, *ns*, respectively.

The percentage of belted trips without a delay provides evidence that drivers tended to avoid the delay by wearing the seat belt. In the U.S. sample, the mean percentage of belted trips without a delay was 72% in the 8-s fixed delay and 81% for drivers in the 8-s variable delay. In the Canadian sample, mean trips without presentation of the delay was 70% for drivers in the 8-s fixed delay and 72% for those in the 8-s variable delay.

The data logger recorded few instances in which drivers removed their seat belts during trips. During the first baseline and intervention periods, drivers removed their seat belts during less than 1% of the U.S. trips. Canadian drivers removed their belts more often. During the initial baseline, Canadian drivers removed their seat belts a mean of 2% of trips during the fixed delay and 4% during the variable delay. During the intervention, mean seat belt removal was 2.5% during the fixed delay and 1.7% during the variable delay. Removal occurred during 2% of trips for vehicles during the fixed delay and 1.6% of trips during the variable delay in the return to baseline. The mean percentage of times Canadian drivers removed seat belts during the variable delay was influenced largely by drivers of three vehicles. These three drivers removed their seat belts on almost a quarter of trips during the variable-delay condition.

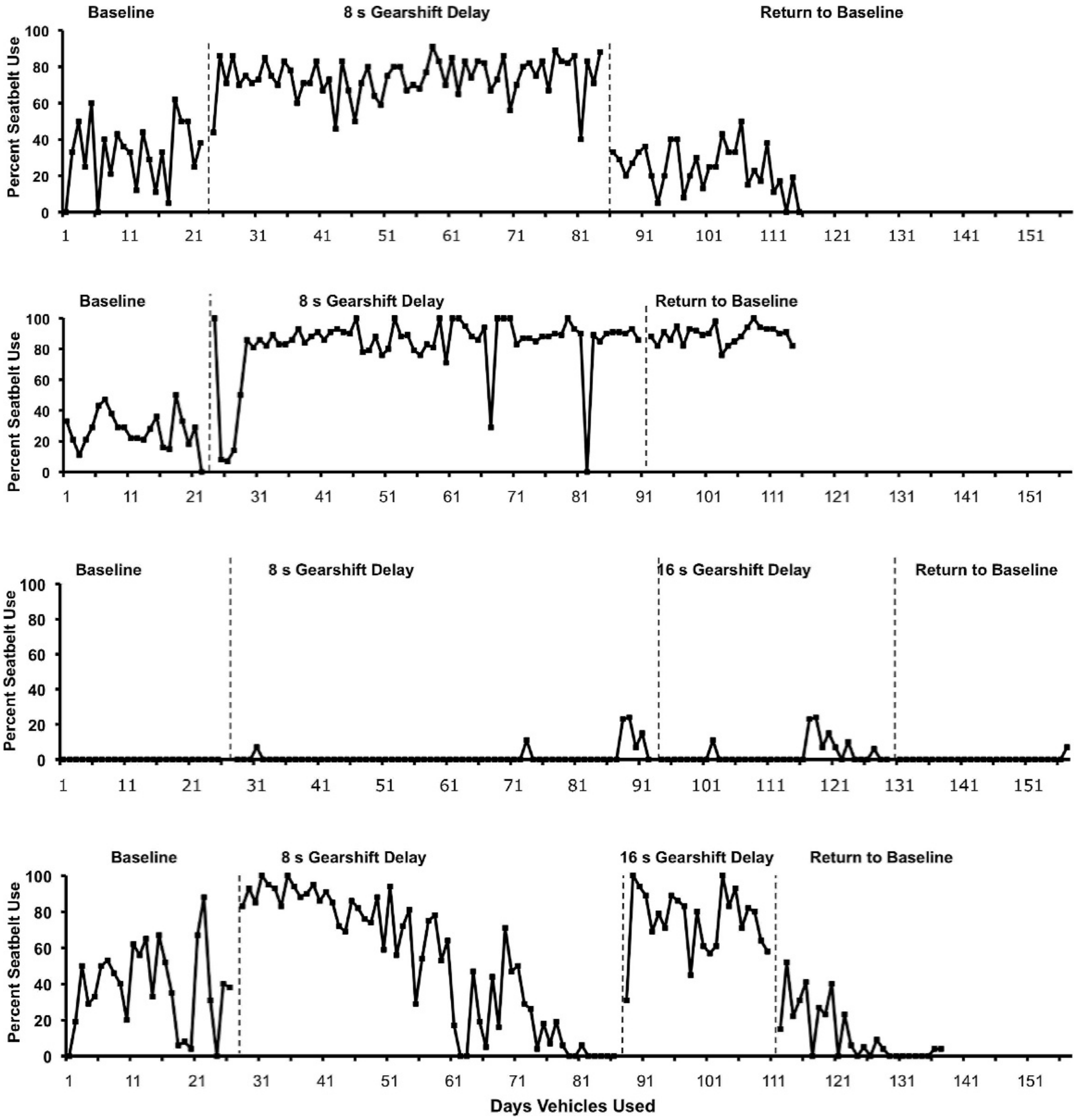

Figure 2. Data for four sample drivers.

Figure 2 provides sample individual data. The top panel shows data from a driver who demonstrated an increase in seat belt use following the 8-s delay and a decline when the delay was removed. The second panel shows the data from a driver who demonstrated an increase following the introduction of the delay and maintenance following its removal, and the third panel shows data from a driver for whom there was no effect when the delay was introduced or increased from 8 to 16 s. The bottom panel shows the data of a participant who initially showed an increase in seat belt use following the introduction of the 8-s delay followed by a gradual decline in seat belt use. After the 16-s fixed delay was introduced, seat belt use improved.

During focus group discussions, most drivers (56%) indicated that the system increased their seat belt use, although some drivers (9%)

reported that the system decreased or did not alter their seat belt use. The breakdown was essentially the same for those in the fixed- and variable-delay conditions. Four drivers with no evidence of bypassing the system said they could bypass the delay by methods that were found to be ineffective during pilot testing. Reported approaches included buckling the seat belt behind the driver and leaving the seat belt buckled. One driver said that he could sometimes bypass the system by pressing the brake and shifting into neutral at the same time. However, the research team had discovered this problem when pilot testing the device and had corrected it with a change to the software and hardware prior to the start of the study and tested it after installation to ensure the system was working. Therefore, it is unlikely that this method actually worked. This driver also showed a large increase in seat belt use following the introduction of the treatment. The one reported bypass method that did appear to work was used by one driver who left the engine in neutral with the emergency brake on. This method bypassed the delay because the vehicle was not returned to park.

All but one driver felt the device would be something that parents would want for teenage drivers. However, most drivers indicated that the system was annoying because it required them to wear their seat belts when moving the vehicle on site or on very short trips. These drivers may not have been able to place the vehicle in the inactive mode because their seat belt use did not consistently meet the 80% criterion for deactivating the delay. Several drivers who mentioned this problem thought it would be useful to have a device that required seat belt use only over a certain speed. In general, drivers felt that the system was acceptable for long trips. One driver felt that a voice prompt would be better than the chime, and another thought a bright flashing light to accompany the delay would be effective. Some drivers had no problem with the system, and others said they got used to it over time. One driver said it increased seat belt use in his personal vehicle.

DISCUSSION

The results of this study support the effectiveness of a short 8-s gearshift delay with both U.S. and Canadian drivers. Although the overall intervention was effective, there was no interaction between gearshift delay type (fixed or variable) and intervention condition; the fixed- and variable-delay schedules were equally effective. Thus, reducing the predictability of delay length did not have the expected results of increasing seat belt use over a more predictable delay length. Seat belt use appeared to decline across the intervention phase, but the drop was not significant. The data also show that once buckled, drivers remained buckled throughout the trip.

A portion of the U.S. sample received a 16-s gearshift delay when the 8-s delay was not effective. Geller et al. (1990) recommended such incrementally intensive interventions to change the behavior of reluctant individuals. However, individual results indicate that some drivers exposed to the 16-s delay had relatively high seat belt use during the baseline and intervention phases. In other words, some of the individuals who experienced the longer delay may not have belonged to the reluctant group of seat belt users. Using a criterion of low seat belt use rather than low response to initial treatment may have led to different results associated with the 16-s delay. Alternatively, the lack of differences between the 8- and 16-s interventions may simply indicate that the longer delay was not sufficiently aversive to the drivers to increase seat belt use to avoid the delay.

The results also indicated that although many drivers avoided the delay by buckling before applying pressure to the brake pedal, they continued to display a proportion of escape responses after the delay was applied. Because drivers needed to engage in at least 80% seat belt use to avoid the delay for trips shorter than

30 s or occasions when they fastened their seat belts within 30 s of motion, a substantial proportion of drivers rarely had the device in the inactive monitoring mode. This suggests that a longer definition of brief trips may have been more effective.

The focus groups indicated that drivers tended to underestimate whether the system increased their seat belt use. Many drivers reported that the system was annoying because it required them to wear their seat belt during short trips. These drivers may not have been able to achieve the 80% seat belt use criterion that allowed the driver to drive unbelted on trips shorter than 30 s. Some drivers stated that they would prefer a delay that occurred only if the driver exceeded a criterion speed. All but one driver felt that the device would be useful to increase the seat belt use of teenage drivers. Teen drivers may be an appealing target population for this technology, because this population buckles less frequently and crashes more often than older drivers. Given the increased crash risk among teens, parents may view such a system as an attractive means of ensuring that their teenaged children are buckled.

The effectiveness of the intervention was based on a negative reinforcement contingency; unbelted drivers could terminate the chime and the delay by fastening their seat belts. Drivers could avoid the delay by buckling their seat belt before attempting to place their vehicles in gear. There is a tipping point, however, at which the amount of the delay becomes so aversive that the drivers engage in other behaviors (e.g., disabling the device) to escape the contingency.

A major advantage of an in-vehicle contingency is that it is immediate and certain rather than unpredictable, as is the case with seat belt enforcement by law enforcement officers. Another advantage is that the data logger can be set to change based on individual behavior over the last sequence of trips, thus reinforcing consistently good behavior.

One disadvantage of the device is that it can be installed only at low cost on vehicles with an automatic transmission (vehicles with a standard transmission do not have a solenoid that prevents shifting out of neutral, whereas vehicles with an automatic transmission have a solenoid to prevent shifting out of park if the driver's foot is not on the brake). A procedural limitation of this study was the failure to produce a reversal in some participants. Although maintenance of treatment effects when the treatment is withdrawn shows evidence of learning, it does not allow one to determine whether the treatment was irreversible for these participants or whether some other variable was responsible for the initial change in behavior. The use of a multiple baseline design across participants indicates, however, that other variables were not likely to be responsible for the change. Another limitation was the inclusion of some participants with high initial seat belt use. We initially selected vehicles with drivers who showed inconsistent seat belt use. However, the delay between the collection of observational data on seat belt use and introduction of the installation of the devices led to changes in drivers for some of the selected vehicles. It also would have been desirable to download data more often so phases could be changed when data stabilized. In future research, we plan to use a data modem to download data remotely on a regular basis. Finally, we did not have time to reintroduce the treatment before completing the study.

In summary, this field study showed that a gearshift delay resulted in a 40% and 37% increase in seat belt use among the U.S. and Canadian commercial fleet drivers, respectively. Some drivers consistently bypassed the system, but many of these problems could be addressed in future work by refining the systems. Focus group results suggest that future research should assess the effects of this system on teenage drivers. Finally, research should continue to focus on the balance between driver acceptance and behavior change.

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