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Understanding commercial truck drivers' decision-makin process concerning distracted driving

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ABSTRACT

A concurrent mixed methods design was used to explore personal and workplace factors, informed by the Theory of Planned Behavior, that affect truck drivers' decision-making about distracted driving on the job. Qualitative data were collected via semi-structured interviews with experts in truck safety and distracted driving, and quantitative data were collected via online survey of truck drivers in the United States. Findings from the interviews illustrated how drivers perceived distractions and the importance of supervisors enforcing organizational distracted driving policies. Survey results found that behavioral intentions were most important in regards to texting and crash and near-crash outcomes, while perceived norms from management best described the correlation between dispatch device use and negative crash-related outcomes. By using a mixed methods design, rather than two separate studies, these findings revealed nuanced differences into the influence of supervisors on distracted driving.

1. Introduction

Distracted driving is increasingly becoming a hazard to drivers in the United States (U.S.) (Royal, 2003; Ascone et al., 2009; Centers for Disease Control and Prevention, 2013). Drivers are distracted from primary driving tasks by (1) visual distractions that take their eyes off the forward roadway; (2) auditory distractions that take their aural perception from relative driving cues; (3) cognitive distractions that take their mind off the driving task; and (4) manual distractions that take the driver's hands off the wheel (Ablassmeier et al., 2007; Governors Highway Safety Association, 2011). Although much of the increase in distracted driving is due to the use of cell phones and other electronic communication (Eby et al., 2006; Wilson and Stimpson, 2010), truck drivers face additional work-related distractions that stem from their occupational environment, including interacting with a dispatch device and writing notes or a log (Olson et al., 2009). When driving on the job, truck drivers are faced with work and time pressures that influence their decision-making about whether or not to undertake distracting tasks (Caird and Kline, 2004).

Research from the Virginia Tech Transportation Institute (VTTI) has demonstrated how the odds for crashes and near crashes are increased when truck drivers are distracted (Olson et al., 2009). The authors found that for truck drivers, texting while driving increases the odds ratio (OR) for crash or near crash 23 times compared to when drivers are not texting (Olson et al., 2009). This study also found a significantly increased odds of crash or near crash for several activities including, interacting with the dispatch device (OR = 9.9), reaching for an electronic device (OR = 6.7), looking at a map (OR = 7.0), and dialing a cell phone (OR = 5.9) (Olson et al., 2009). Because motor vehicle crashes are the leading cause of occupational death in commercial truck drivers (Bureau of Labor Statistics, 2012), it is important to prevent crashes caused by distraction.

The purpose of this study was to gain insight into how commercial truck drivers make decisions concerning whether or not to undertake different distractions on the job. The research used quantitative and qualitative methods, and was guided by the Theory of Planned Behavior. The results will be useful in generating recommendations for prevention strategies for distracted driving among American truck drivers.

1.1. Theory of planned behavior

The Theory of Planned Behavior (TPB) (Ajzen, 2005) is a framework for understanding factors that affect individuals when they consider whether or not to undertake a given behavior. The

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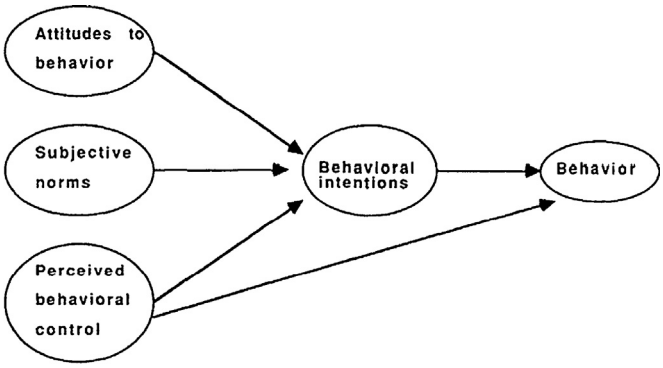

Fig. 1. Conceptual model of the Theory of Planned Behavior (from Parker et al., 1992).

TPB, as shown in Fig. 1, seeks to understand how attitudes, perceived behavioral control (PBC), subjective norms, and intentions affect behavior performance (Parker et al., 1992; Ajzen, 2005). A study of truck driver safety in the United Kingdom by Poulter et al. (2008) used the TPB to understand what factors would be most effective in increasing "safe driving behavior" (not including distracted driving specifically) and compliance with safety regulations (Poulter et al., 2008). Poulter et al. (2008) found that while subjective norms affected safe driving behavior, truck drivers' compliance with driving regulations ("rule compliance") was more affected by PBC. As a result, the authors concluded that programs aimed at increasing safe driver behavior and rule compliance would require two different approaches (Poulter et al., 2008).

The TPB has been used to understand truck driver behavior and distracted driving in young drivers (Hafetz et al., 2010). Thus, we hypothesized that it would be an appropriate framework for examining distracted driving in commercial truck drivers. Prior investigations that used the TPB only included quantitative analyses; thus, they were only able to explore correlations between driver behaviors and outcomes. The current study used a mixed method design not only to examine these correlations using a quantitative analysis, but also explore why these correlations exist through qualitative inquiry (Howe, 2008).

This study examined the relationship of different components of the TPB to distracted driving on the job for commercial truck drivers. In addition, specific components of the TPB were examined to determine which were most predictive of unsafe driving behaviors across two different distracting activities (texting while driving and using dispatch devices). Although prior examinations of TPB and driving behavior mostly used quantitative methods, the current study relied more heavily on the qualitative methods. By including qualitative data, our study allowed for a more nuanced understanding of the effects of distraction on truck drivers (Howe, 2008; Mazzola et al., 2011), above and beyond what would have been captured by using quantitative data alone. This concurrent mixed methods study design produced qualitative and quantitative results of equal weight, giving us the depth and texture of qualitative analysis as well as the breadth and generalizability of survey analysis.

2. Materials and methods

This study employed a mixed methods concurrent design and analysis (Tashakkori and Teddlie, 1998; Onwuegbuzie and Johnson, 2008). In a mixed methods concurrent design, the qualitative and quantitative data are collected and analyzed separately. The results of each method are presented separately and then integrated for interpretation (Barg et al., 2006; Luzzo 2008). Fig. 2 illustrates how

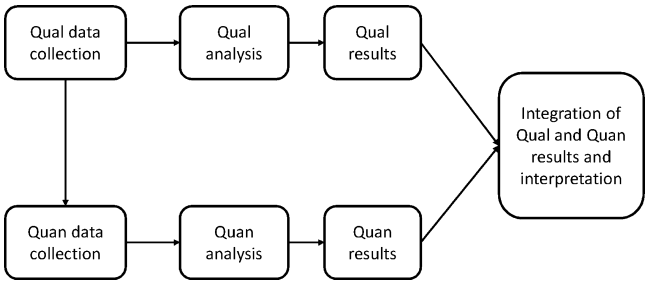

Fig. 2. Visual diagram of the analysis of qualitative key informant interviews (Qual) and quantitative analysis of surveys (Quan). This visualization is based on Plano Clark's and Creswell's interpretation (Plano Clark and Creswell, 2008) of Luzzo's mixed methods analysis (Luzzo, 2008).

the qualitative and quantitative results are triangulated in the current study, that is, how the results from the one method converge, correspond, or corroborate those from the other method (Greene et al., 2008). The methods section will first describe qualitative data collection and analysis, then the quantitative data collection and analysis. The Institutional Review Board from the authors' university approved of all study procedures.

2.1. Qualitative data collection

Consistent with prior research using the TPB, we first conducted a qualitative elicitation interviews before the surveys. In a traditional quantitative TPB study, the purpose of these interviews would have been only to elicit the appropriate context for generating the TPB questionnaire (Montano and Kasprzyk, 2002). Usually, the goal of the elicitation interviews would be to construct a valid questionnaire for the theory-specific determinants of the behavior of interest; however, for this research the key informant interviews included additional items to gain a more in-depth examination of how each TPB construct could affect decision making across a broad range of potential distractions, include distractions that would not be on the survey.

Key informant interviews were conducted to elicit information on the four central TPB constructs – attitudes, intentions, norms, and PBC – as they described distracted driving in commercial truck drivers (Montano and Kasprzyk, 2002). A purposive sample of experts in truck driver safety or distracted driving were recruited from the list of attendees at the Symposium on Prevention of Occupationally-Related Distracted Driving sponsored by the Johns Hopkins Bloomberg School of Public Health Occupational Safety and Health Education and Research Center on April 18, 2011 in Laurel, MD (the symposium had 125 registered attendees) (JHSPH, 2011). Participants were selected from attendees at this symposium because of the organizations that they were representing as well as their interest in distracted driving. At the conclusion of each interview, participants were given an opportunity to suggest other individuals who were knowledgeable on the topics that the interview had addressed. This process of snowball sampling yielded seven additional participants (Lofland et al., 2006).

The interview guide was developed and refined by the study team, following the guidelines for TPB elicitation surveys (Montano and Kasprzyk, 2002). Beyond identifying appropriate distractions and social influences on truck driver behavior for the subsequent survey, the interview guide sought to elicit more detail about how the drivers would react to and interact with various potential distractions. The survey was finalized after pilot testing with an expert in the safety of commercial truck drivers who was also a former driver. Semi-structured interviews were conducted via Skype (Microsoft Corp., Redmond, WA) and were recorded using MP3 Skype Recorder v3.1 (voipcallrecording.com). Audio

files of the interviews were transcribed by uploading the .mp3 files to productiontranscripts.com (Production Transcripts, Glendale, CA). Data collection ceased after 11 interviews, which was the point when data saturation was reached (Guest et al., 2006). The recording failed to capture one interview; thus, only 10 of the 11 interviews were successfully transcribed. However, interviewer notes for all 11 interviews were successfully coded and analyzed. Data collection began in December, 2012 and ended in January, 2013. All interviews were conducted by the lead author of this study.

The purposive sample included a variety of perspectives. Five of the interview participants were researchers at academic institutions with expertise in distracted driving among the general population and truck drivers, specifically. Three interview participants were researchers at private research institutions with expertise in behavioral sciences and distracted driving. One participant was involved in union leadership at a national union representing truck drivers. One participant worked in fleet logistics for a company with a fleet of over 1000 company-owned trucks of varying sizes. The final participant worked for the National Transportation Safety Board investigating fatal crashes involving commercial vehicles. Because participants were guaranteed anonymity, no demographic data were collected.

2.2. Qualitative data analysis

The 10 transcripts and 11 sets of notes were saved as Microsoft Word documents. Participants' responses were open-coded line-by-line to identify the initial themes that were found commonly across the interviews and to label responses that reflected TPB constructs (Emerson, 2001; Yin, 2011). Responses concerning the TPB constructs for texting and dispatch device use while driving were used to create the quantitative survey items (the rationale for selecting these two behaviors for the survey is described below). Focused coding, or level-2 coding, was employed to group themes into broader categories. A codebook resulted from the focused coding process. A second coder, hired for the study, independently coded a subset of three randomly-selected interviews as a check on the reliability of the coding process. Both coders met to discuss the coding and how well the codebook described the categorizations of the data (Frattaroli et al., 2012). While the two coders differed slightly in their choice of wording of themes, no substantive differences emerged between both sets of codes.

Before exploring the factors that affect distracted driving in truck drivers, interview participants were asked to give their personal definition of distracted driving. Asking for a definition of distracted driving from each participant served two purposes: (1) to insure that the interviewer and participant were using the same definition of distracted driving; and (2) to examine the ways an individual's definition differed from the what is conveyed by published literature and what we might learn from these differences. To establish which distracted driver behaviors were appropriate for the online survey of drivers, interview participants were asked to give their opinions on how distracting certain behaviors would be to truck drivers, including texting while driving; reading the dispatch device; and writing notes or a log, etc. (Montano and Kasprzyk, 2002). Using a Likert scale, interview participants rated on a scale of one (not very distracting) to five (very distracting) 19 distracting behaviors described by the VTTI (Olson et al., 2009; Hickman et al., 2010), and confirmed as relevant during pilot testing.

From these ratings and descriptions of the different activities by the interview participants, two behaviors were selected for analysis in the online survey. One was "texting while driving," which was selected because it was given a maximum distraction rating by every interview participant. The second behavior selected was "interacting with a dispatch device," which was rated almost as distracting as texting, and was also a behavior specific to the occupational environment of truck drivers.

2.3. Quantitative data collection

Quantitative data were collected via online survey. Members of the International Brotherhood of Teamsters (IBT) in the U.S. were selected as a target population for the survey. The IBT represents over one million truck drivers and union members in other occupations in the U.S. and Canada (International Brotherhood of Teamsters, 2013). The IBT was selected in part due to its size and nationwide reach. This research benefited from guidance in developing the study from the head of Occupational Safety and Health for the IBT in Washington, D.C. This IBT official understood the importance of the research and served as a gatekeeper into the IBT population (Lofland et al., 2006). A business representative from an IBT local who was familiar with the project assisted the study team in finalizing the exact wording of the survey and helped assess the face validity of the items. The survey took 10 min to complete upon pilot testing. With the assistance of IBT personnel, we sought to recruit divisions where the drivers were most likely to experience the distractions under study (International Brotherhood of Teamsters, 2012). To identify drivers in the car haul, express, freight, motion picture, package, and tankhaul industries, study participants were asked to select the type of truck that they drove (with accompanying images) at the beginning of the survey. Those who did not identify one of the selected vehicles were directed to a disqualification page and thanked for their time. Survey participants were offered the chance to enter a raffle to win an i Pad as compensation for their time for taking the survey.

Survey subjects were recruited via an announcement posted to the IBT website, www.teamster.org. Of the 440 subjects who entered the study, 79 (18%) were excluded because in answering the survey screening question they indicated that they did not drive one of the vehicles included in the study. All subjects responded to questions on texting while driving, referred to from here on as the "texting group." After completing the questions about texting, the subjects were asked if they used a dispatch device while driving. If they answered yes, they answered questions about dispatch device use, referred to from here on as the "dispatch device group." Although the survey was only 10 minutes long, over 100 subjects dropped out without completing the texting and/or dispatch questions. Fig. 3 displays how we arrived at the final population of 277 subjects (77% of the total eligible survey) in the texting group and 169 subjects (42% of the total eligible survey) in the dispatch device group.

Of the texting group, 26% of subjects indicated that they drove delivery vans (i.e., were in the package industry) and 74% drove larger trucks. The dispatch device group was comprised of 35% delivery drivers and 65% larger trucks. There was no statistically significant difference in the distribution of vehicles driven by the texting and the dispatch device groups, or the $n = 68$ subjects who dropped out before completing the survey (Pearson's χ^2 p-value = 0.4). We have no data on the $n = 79$ subjects that were screened out as not driving vehicles in the target population.

The survey was administered using an online data collection tool (SurveyMonkey Inc., Palo Alto, CA) that was open between April 2 and May 19, 2013. Survey data were downloaded from SurveyMonkey into Stata v12.1 for analysis (Stata Corp, College Station, TX).

2.3.1. Independent variables

All subjects entered anonymous demographic data on gender, age, years driving experience, and estimated weekly driving hours. Table 1 is a description of how the TPB items were presented for

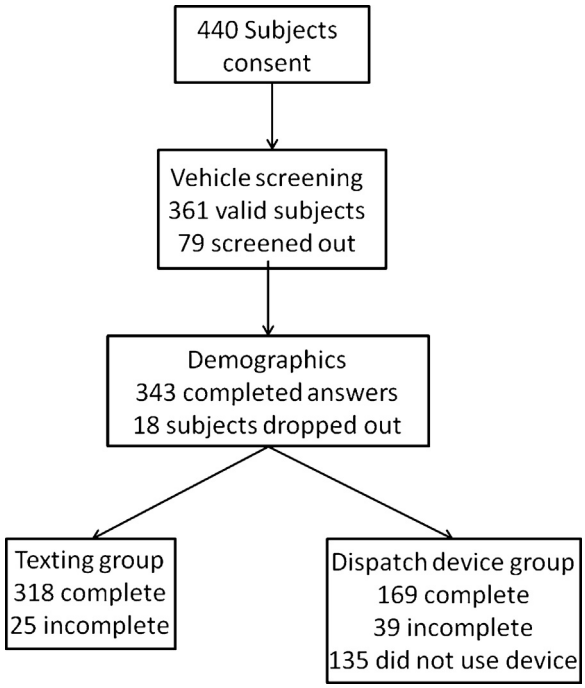

Fig. 3. Flow chart of screening and drop outs for the texting and dispatch device populations.

both texting and dispatch device use. The TPB constructs were scored in a manner consistent with prior research (Montano and Kasprzyk, 2002). Attitude was assessed using the average of three semantic differential 7-point bipolar scales; intentions were measured using a single semantic differential 7-point bipolar scale; PBC was the product of multiplying a control belief, measured on a [−3, 3] scale, by a power belief, measured on a [1, 7] scale; norms were the product of multiplying a normative belief, measure on a [−3, 3] scale, by the motivation to comply, measured on a [1, 7] scale.

Although previous studies on driver behavior and the TPB have used mean scores to analyze each TPB construct (Parker et al., 1992; Walsh et al., 2008), our data were not normally distributed and clustered around certain responses. Thus, categorical variables were created for the TPB components. Table 1 also displays the categories of and distributions for each variable for both the texting and dispatch device populations.

2.3.2. Dependent variables

To assess the effects of distraction on dangerous driving, subjects self-reported if they ever experienced a series of safety critical events while on the job (Hanowski et al., 2006). Subjects first reported whether or not they ever had a crash while on the job. After being reminded that distracted driving encompasses any activities that that take the driver's eyes, hand, or concentration away from the primary driving task, subjects reported whether or not they ever had a crash while distracted, had to brake hard to avoid a crash while distracted, and swerve to avoid a crash while distracted. These four outcomes served as the dependent variables in four separate regression analyses in both the texting and dispatch device populations.

2.4. Quantitative data analysis

Means and standard deviations (SDs) were calculated for age, years driving experience and weekly driving hours. Descriptive analysis of the categorical TPB variables was conducted. To validate the TPB's conceptual model (Fig. 1), we examined whether or not intentions mediated the effects of the other TPB variables on the four outcomes (Vittinghoff et al., 2005). Testing this model required a multi-step process. First, a bivariate analysis was used to examine the correlation of norms, PBC, and attitudes to

Table 1
Generation and distribution of TPB components for regression analyses. Items are listed generically for either behavior: texting or dispatch device use.

Component	Assessment	Items	Response range	Item scale	Distribution for texting group (n = 277)	Distribution for dispatch group (n = 153)
Attitude	Direct, multi-item	[Behavior] on the job is:	Very unpleasant; very pleasant	1–7	Negative attitudes on all three items (73%)	Very negative attitudes (50%)
			Very harmful; very beneficial	1–7	Any other attitudes (27%)	Negative attitudes (20%)
			Very bad; very good	1–7		Neutral and positive attitudes (30%)
Norms	Indirect, dual-item	My supervisor thinks I should/not [behavior] while driving on the job	Thinks I should; thinks I should not	1–7	Supervisors oppose texting and strong motivation to comply (47%)	Supervisors strongly oppose use and strong motivation to comply (35%)
					Any other norms (53%)	Supervisors opposed and strong motivation to comply (29%)
		How important is your supervisor's opinion about [behavior] while driving on the job?	Very unimportant; very important	−3 to 3		Neutral motivation to comply regardless of supervisor's opinion (14%)
						No motivation to comply regardless of supervisor's opinion (22%)
Perceived Behavioral Control	Indirect, dual-item	I believe that I can avoid [behavior] while driving on the job for the next 3 months	I would not avoid [behavior]; I would avoid [behavior]	−3 to 3	Easy to avoid texting and will not text (70%)	Confident towards avoiding dispatch device use (54%)
		How easy or hard is it for you to not [behavior] while driving on the job?	Very hard not to [behavior]; Very easy not to [behavior]	1– 7	Any other control beliefs (30%)	Not confident towards avoiding use (46%)
Intentions	Direct, single-item	I intend to avoid [behavior] while driving on the job in the next 3 months	Definitely will [behavior]; definitely will not [behavior]	1–7	Strongly intend not to text (79%)	Intend not to use dispatch device (64%)
					Any other intention (21%)	Neutral intentions or intend to use (36%)

intentions separately for both texting and dispatch device use (Parker et al., 1992; Walsh et al., 2008). Second, bivariate analysis was used to examine the association of each of the four TPB constructs for texting and distracted driving with the four crash and near crash outcomes. Third, multivariate regressions were initially conducted without intentions, then including intentions to see if it attenuated the effects of the other three TPB constructs. Specifically, we sought to determine if the odds ratios (ORs) for norms, PBC, and attitudes decreased and if the significance level was affected. A change in the ORs towards 1.0 and/or decreasing significance of the *p*-values of the ORs was considered to be a mediation effect. Demographic variables that had a bivariate correlation with the outcome variable with a *p*-value $\leq$0.10 were included in the multivariate analyses (Vittinghoff et al., 2005).

3. Results

3.1. Qualitative analysis

This section first presents the qualitative results for how the participants defined distracted driving and whether or not the participants had knowledge of the involvement of distraction in crashes of truck drivers. Next, data are presented regarding how the components of the TPB affect whether or not truck drivers would drive distracted on the job.

When asked to describe what distracted driving meant to them, some interview participants went beyond the definition of distracted driving based on the literature (i.e., visual, auditory, cognitive, and manual). Three participants expressed the belief that non-driving activities rose to the level of "distractions" only when driving performance was impacted. One participant was concerned that the distracting task was prioritized over driving and that safely operating the vehicle then becomes a secondary task. Most of the participants were concerned for the drivers' decreased driving performance, but as one participant pointed out, while drivers might think that they are increasing their work efficiency by undertaking a second task, there is also a diminished capacity to carry out that second, distracting activity. Interview participants were able to describe situations where drivers crashed or came near to crashing when distracted. Only one of the 11 participants said that he/she did not know of any crashes involving distracted truck drivers and further stated that he/she doubted that any driver would admit to driving distracted after a crash.

All interview participants were asked to comment on whom would influence drivers' decision-making for three or four distinct behaviors, such as texting, dialing a phone, eating or drinking (many behaviors were repeated in multiple interviews). Each participant stated that supervisors and/or management would positively, negatively, or both influence drivers' decision-making for at least one, if not all, of the behaviors that their interview covered. No other social referents were named nearly as frequently. Although the interviewer probed respondents by suggesting other potential social influences, such as family members or coworkers, it was clear that the participants believed that supervisors had the biggest influence on drivers' decision-making process.

In assessing attitudes, interview participants were able to identify pros and cons of a wide variety of behaviors. Dispatch devices and cell phones (both personally owned and owned by the company) were identified as ways for management and drivers to stay in touch. Benefits to staying connected with these electronic devices included updating information, route planning, informing customers on arrival times, and being able to make emergency contacts. Drivers also could benefit from being in phone contact with friends, family, and coworkers. According to the interview participants, being in phone contact with family members, either via phone calls or text messages can give the drivers peace of mind from being able to check up on family members. Interview respondents also stated that drivers could use talking on the phone as a way to ward off fatigue, especially during late night driving or during long stretches on the road. Finally, drivers might try to complete work tasks that they perceive as simple, such as writing notes or a log, so that they are not required to complete paperwork upon arrival at their destination.

Even with these potential benefits, interview participants strongly condemned many of these distracting activities, saying that benefits were minor in comparison to the potential negative consequences. One interview participant was specific about the main drawback when he/she said:

"So it goes then beyond what were they doing specifically to their eyes are off the road. And so it doesn't really matter whether they were texting, or reading the newspaper, or interacting with the dispatching device. The bottom line is that their eyes were off the forward roadway."

Interview participants discussed all aspects of visual, cognitive, and manual distractions as drawbacks. Comparing the different distracting behaviors, participants said that whatever tasks took the longest or involved multiple forms of distraction (e.g., both visual and cognitive) were the most hazardous. Overall, interview participants felt that drivers would have negative attitudes towards distracting tasks when they weighed the pros and cons.

Interview participants believed that drivers had a great deal of personal control over whether or not they undertake distracting behaviors while driving on the job. Even though work pressures or family pressures might influence drivers to feel that they would need to undertake a secondary task, all the interview participants felt that it was ultimately up to the driver to make the decision. In the words of one participant, "I mean the decision ultimately rests on the driver. [There are] pressures from things that would weigh into that. But to engage in the actual activity while driving is completely under his control." However, some participants also described a range over control of distracting activities. For example, one participant stated that when reaching for objects in the vehicle cab, the more occupation-related an object is, the less control that the driver has over that choice whereas the more personal an object is, the more control the driver has over that choice. Participants described how drivers might not feel free to undertake distracting activities when facing heavy traffic or construction zones where the driver's full attention was needed for driving.

Organizations could reduce drivers' control over distracting activities by having strong, clear policies against distracted driving. According to interview participants, strict enforcement of these policies would be an effective deterrent, thus inhibiting drivers' freedom to undertake distracting activities. Two interview participants cited DriveCam (manufactured by The Driver Science Company, San Diego, CA) as one method for monitoring driver behavior. Monitoring company-owned cell phones were another method cited by participants for management to monitor cell phone use while driving. Fear of punishment from the employer would discourage drivers from driving distracted, effectively reducing their control over that given behavior.

One other influence on PBC and norms cited by interviews participants were laws and law enforcement. In 2010, the Federal Motor Carrier Safety Administration issued a rule stating that commercial truck and bus drivers were prohibited from texting while driving (Federal Register, 2010). One participant stated that the ban, which prohibits truck drivers from texting with a phone or dispatch device, will be helpful in creating an organizational safety culture where distracted driving was not the norm. Not only does this ban create a list of prohibited activities that employers know that drivers should not be undertaking, but also the regulation allows for an $11,000 fine for the vehicle's owner (Federal Register,

Table 2
Descriptive data on the respondents to the components of the TPB questions for texting while driving and reading the dispatch device while driving.

Texting while driving sample ($n = 277$)			
	Mean	SD[a]	Minimum–maximum
Age (years)	48	8.8	21–69
Driving experience (years)	22.8	10.1	1–45
Weekly driving (hours)	47.6	11.6	6–70
Using the dispatch device while driving sample ($n = 153$)			
	Mean	SD	Minimum–maximum
Age (years)	46.4	8.4	21–69
Driving experience (years)	21.2	9.3	1–44
Weekly driving (hours)	47.6	11.3	6–70

[a] SD: standard deviation.

2010). This penalty should give further motivation to organizations to ensure that their drivers are not texting while driving.

3.2. Quantitative analysis

Table 2 describes the demographics of subjects who completed the texting and dispatch device sections of the survey. Men dominated both samples of drivers, comprising 96% of the texting group and 95% of the dispatch device group. Participants reported an average of over 20-years of experience driving and more than 40 h driving per week.

Table 3 describes the reported crashes and near crashes for each of the two populations. Over half of the subjects in both the texting group and the dispatch device group reported ever crashing on the job, with less than 20% in each group reporting distraction-related crashes. Respondents were fairly evenly split on experiencing a distraction-related near crash, both for hard braking and swerving.

3.3. Regression analyses

3.3.1. Texting group

Results for the texting population are presented first, followed by results for the dispatch device population. In bivariate analyses for the texting population, norms was associated with ever experiencing a crash and distraction-involved swerving; PBC and intentions were associated with distraction-involved swerving and distraction-involved braking; and attitudes were not associated with any of the four outcomes.

Findings from the first step of a mediation analysis indicated that attitudes, norms, and PBC were significantly associated with intentions in logistic regression analysis for both texting and dispatch device use populations. Table 4 presents the multivariate analyses for the texting population for the two outcomes (distraction-involved hard braking, and distraction-involved swerving) for which there were significant multivariate results. Drivers who did not state that texting was easy to avoid (PBC) were associated with increased odds of distraction-involved hard braking; however, these effects were mediated by intentions. For distraction-involved swerving, intentions mediate the effects of PBC and norms.

3.3.2. Dispatch device group

For the dispatch device population, all four TPB constructs were associated with the distraction-involved outcomes: crash, hard braking, and swerving. None of the TPB constructs were associated with ever experiencing a crash. Table 5 presents the results of mediation analysis for experiencing a distraction-involved crash and experiencing distraction-involved swerving. None of the demographic data or TPB constructs were associated with distraction-involved hard braking in multivariate regression. Subjects who stated that they had neutral motivation to comply regardless of supervisor's opinion were at increased odds of crashing compared to the norms reference group; intentions did not mediate these effects. Both subjects who stated that they had neutral motivation to comply regardless of supervisor's opinion and subjects who stated that they had no motivation to comply regardless of supervisor's opinion were at increased odds of experiencing distraction-involved swerving compared to the norms reference group; intentions also did not mediate these effects.

3.4. Synthesis of qualitative and quantitative results

The regression analyses supported the TPB framework displayed in Fig. 1 for texting, but not for dispatch device use. In the interviews, participants reported feeling that drivers ultimately had control over whether or not they undertook distracting activities, yet one participant stated that drivers had less control over distractions that were more work-related. Drawing from both the quantitative and qualitative analyses, it is possible that drivers felt that they had much better control over their choices surrounding texting than dispatch device use. The quantitative results for the texting population support this conclusion, as intentions mediates the effects of PBC on distraction-involved near crash outcomes. Yet for the dispatch device use, intentions were more varied, and thus the social norms from drivers' supervisors were most important in determining distracted driving behavior.

In Table 1, drivers indicated negative attitudes towards texting and dispatch device use. Although interview participants believed that drivers would find some positive reasons to undertaking the distracting behaviors, the qualitative and quantitative data together reveal that drivers have negative attitudes about distracted driving on the job. Interview participants believed that drivers would view distractions negatively; however, because they were not drivers themselves, they were unable to speak directly to drivers' intentions. In this case, the quantitative results provide insight into an aspect of TPB that the qualitative data alone could not provide.

4. Discussion

The results of these analyses support the important role that truck drivers' supervisors play in preventing distracted driving on the job. Interviews with experts in truck driving safety described how management can create a culture that either encourages or discourages distracted driving, while surveys of IBT members demonstrated the importance of organizational norms

Table 3
Reported crashes and near crashes for subjects completing the texting and dispatch device sections.

	Texting sample ($n = 277$)			Dispatch device sample ($n = 153$)		
	Yes	No	Missing	Yes	No	Missing
Any crashes	151 (55%)	124 (45%)	2 (1%)	90 (59%)	62 (41%)	1 (1%)
Distraction-involved crashes	49 (18%)	228 (82%)	0 (0%)	23 (15%)	130 (85%)	0 (0%)
Distraction-involved hard braking	127 (46%)	147 (53%)	3 (1%)	76 (50%)	77 (50%)	0 (0%)
Distraction-involved swerving	121 (44%)	155 (56%)	1 (1%)	68 (44%)	85 (56%)	0 (0%)

Table 4
Mediating effects of intentions towards texting on other TPB constructs for crashes and near crashes on the job (PBC: perceived behavioral control).

	Direct effects		Mediation effects	
	OR	95% CI[c]	OR	95% CI
Ever experience distraction-involved hard braking on the job				
Weekly driving	0.98	0.96–1.00[b]	0.98	0.96–1.00[b]
Norms	1.21	0.72–2.02	1.16	0.69–1.95
PBC	2.4	1.34–4.31[b]	1.66	0.80–3.41
Attitude	0.88	0.48–1.60	0.78	0.42–1.46
Intentions	–	–	2.07	0.70–5.81
Ever experience distraction-involved swerving on the job				
Norms	1.63	0.98–3.08[a]	1.56	0.94–2.61[a]
PBC	1.74	0.98–2.71	1.11	0.53–2.30
Attitudes	1.04	0.58–1.89	0.92	0.50–1.70
Intentions	–	–	2.34	1.01–5.44[b]

[a] p-value < 0.1
[b] p-value < 0.05.
[c] CI: confidence interval.

surrounding text messaging and dispatch device use while driving. Our findings of the importance of supervisors to driver safety is consistent with previous work by Wills and colleagues on a population of professional drivers in Australia (Wills et al., 2005, 2006, 2009). Wills et al. (2006) found that management commitment to safety was the aspect of safety climate most correlated with safe driving behavior (Wills et al., 2006). The mixed methods design used in this study identified that the importance of management for preventing distracted driving varies depending on how if a give distraction is work-related.

Management in motor carrier companies has taken proactive steps to prevent distracted driving. For example, the Network of Employers for Transportation Safety (Network of Employers for Transportation Safety, 2009), a private-public partnership concerned with reducing crashes on and off the job, and the American Trucking Association (Federal Register, 2010), an industry advocacy group, both reported that some of their member organizations had company policies on distracted driving that predated the 2010 federal ban on texting while driving for commercial truck drivers (Federal Register, 2010).

The results of this study reinforce the importance of company policies for driver safety. Interview participants described how clearly enforced, explicit company policies on distracted driving, with no competing implicit expectations, could reduce employee distracted driving. A study of texting prevalence in commercial truck drivers by Hickman and colleagues also found that drivers who drove for organizations with texting bans had a lower prevalence of texting while driving than companies without such policies (Hickman et al., 2010). Enforcement of organizational rules prohibiting electronic communications while driving would affect both drivers' perceived norms and PBC.

The analyses on attitudes towards the two distractions did not produce statistically significant results, which was contrary to what we hypothesized. The attitude construct scores were very low indicating widespread recognition that distractions from texting and dispatch device use are both viewed unfavorably. Because this study employed between-methods triangulation (Jick, 2008), we were unable to interview truck drivers to discern why they had such low attitudes towards texting and dispatch device use. Future research in this area could benefit from further exploration of these driver attitudes towards these specific distractions.

Similar to prior research, this study did not use distracted driving as the outcome of interest. The VTTI study showed that drivers can undertake distractions while driving and not experience any adverse events (Olson et al., 2009). Previous research using the TPB framework has examined intentions to undertake an activity instead of direct observation of the activity itself (Parker et al., 1992; Walsh et al., 2008). Significant correlations were found between intentions and the three other TPB constructs for both texting and dispatch device use. By examining distraction-related crashes and near crashes, our outcomes of interest were instances

Table 5
Mediating effects of intentions towards dispatch device use on other TPB constructs for crashes and near crashes on the job.

	Variable level	Direct effects		Mediation effects	
		OR	95% CI[b]	OR	95% CI
Ever experience a distraction-involved crash on the job					
Driving experience		1.04	0.98–1.09	1.04	0.98–1.09
Attitudes	Very negative attitudes	Reference		Reference	
	Negative attitudes	2.57	0.82–8.11	2.55	0.81–8.03
	Neutral and positive attitudes	0.6	0.12–3.00	0.54	0.10–2.86
Norms	Supervisors strongly oppose use and strong motivation to comply	Reference		Reference	
	Supervisors opposed and strong motivation to comply	1.64	0.34–7.83	1.56	0.32–7.59
	Neutral motivation to comply regardless of supervisor's opinion	8.11	1.52–43.17[a]	7.87	1.47–42.30[a]
	No motivation to comply regardless of supervisor's opinion	2.2	0.45–10.74	2.07	0.41–10.37
PBC		1.74	0.54–5.77	1.49	0.39–5.67
Intentions		–	–	1.36	0.43–3.51
Ever experience distraction-involved swerving on the job					
Attitudes	Very negative attitudes	Reference		Reference	
	Negative attitudes	1.46	0.63–3.40	1.46	0.63–3.39
	Neutral and positive attitudes	0.85	0.30–2.47	0.87	0.29–2.62
Norms	Supervisors strongly oppose use and strong motivation to comply	Reference		Reference	
	Supervisors opposed and strong motivation to comply	2.14	0.85–5.43	2.16	0.85–5.53
	Neutral motivation to comply regardless of supervisor's opinion	5.22	1.26–14.08[a]	4.24	1.27–14.20[a]
	No motivation to comply regardless of supervisor's opinion	5.29	1.89–14.78[a]	5.37	1.90–15.14[a]
PBC		1.31	0.57–3.06	1.38	0.49–3.84
Intentions		–	–	0.92	0.32–2.61

[a] p-value < 0.05.
[b] CI: confidence interval.

when distractions had affected driver safety. This approach to defining distracted driving aligns with the definition of distracted driving given by a few of the interviewees (i.e., a task is only distracting when it affects driver safety). Future research in this area should consider continuing to define distractions as we did in this research.

4.1. Limitations and strengths

This study did not include drivers who are owner-operators, which limits the generalizability of these findings to only union drivers. This distinction is important because owner-operated drivers face work and time pressures that are different from the union drivers that this study examined (Braver et al., 1992). Also, union workers receive more safety training than their non-union counterparts and are less likely to accept hazardous working conditions (Breslin et al., 2008). Because of the effects of the presence of unions, it is possible that the survey populations have safer driving behaviors and better safety climate than non-union drivers in the U.S. Despite this limitation, this research is strengthened because using a sample of IBT drivers allowed us to study drivers of multiple vehicle types across the entire U.S.

The sample size may have limited our results as well. It was difficult to estimate the necessary sample size for a population and outcomes that had previously not been examined. Although we anticipated a sample size of 500 subjects as necessary for analysis, our analyses yielded significant findings with smaller samples ($n = 277$ for texting and $n = 153$ for dispatch device). Thus, although the final sample was relatively small when compared to the target population, the analyses were able to identify important statistical associations.

The distribution of vehicle types for the dispatch device population has a higher percentage of delivery van drivers than was anticipated based on the most recent publicly-available description of the American truck fleet (Census Bureau, 2004). Since there was an 11-year gap between when those data were collected and data collection in the current study we cannot tell if there had been a shift in the distributions of vehicles resulting in a greater percentage of delivery van drivers using dispatch devices compared to drivers of larger trucks. While we were unable to explore this, an ad hoc analysis using a *t*-test revealed that the percent of delivery drivers in the Census study and in ours was not significantly different from one another (data not shown).

While sampling IBT members offers the possibility of a nationwide sample, we did not capture demographic data or geographic locations, which did not permit us to make claims about the type of trucks driven by the study populations to IBT members nationwide. Also, this population was overwhelmingly male, which limits the generalizability of these findings to female drivers. Although, these results are most applicable to truck drivers of similar demographics to those in this research, this study was strengthened by including a variety of drivers. While we do not believe that our sample greatly differs from IBT drivers nationwide, future analyses could explicitly sample drivers from a given IBT industry or for a specific type of commercial truck.

This study was limited in assessment of outcomes of interest because we had to rely on self-reported incidents. Although self-reported incident report has been validated in previous studies of motor vehicle violations (West et al., 1993; Adams and Webley, 1996), methodological issues still remain. Landen and Hendricks caution that recall bias increases when the time period for incidents is beyond 12 months of recall (Landen and Hendricks, 1995). Thus, recall bias may have affected these findings. These data might be also be subject to social desirability; however, anonymous surveys decrease the likelihood of such bias (Mcevoy et al., 2006).

A final limitation was that not all subjects who completed the texting and/or dispatch device sections answered the outcome questions. This study was part of a larger survey of driver behavior and safety climate factors, so there were an additional 35 questions between the end of the TPB sections and the outcome measures. Thus, survey fatigue may have affected the survey completion rate. Despite these limitations, the survey was developed to thoroughly examine driver behavior and safety climate factors, and reducing its length was not possible given the study goals.

4.2. Benefits of the mixed methods study design

Through the triangulation of qualitative and quantitative results, we identified important nuances in the factors that influence decision-making concerning distracted driving in commercial truck drivers. Without the interviews, we would have needed to collect additional data to explain why the TPB framework was supported for texting but not for dispatch device use. The mixed methods results synthesis allowed us to identify work-relatedness as important for determining which factors influence driver decision-making. Thus, our results are applicable for indicating how supervisors should intervene to reduce different kinds of distractions.

This study was not designed to examine the same populations with both the quantitative and qualitative methods; it is possible that had we used actual drivers for the TPB elicitation survey, different distracted driving behaviors and constructs would have been identified. However, by collecting and analyzing qualitative data from experts who have a wealth of experience in understanding drivers and their work context, we felt that we achieved both more breadth and depth in eliciting the information. We believe that ultimately this approach to using a mixed methods design strengthens our results. Overall, most research conducted on occupational risk factors is quantitative in nature, the qualitative data used in this study provided important context for the findings that would not have been able to obtain using surveys alone (Mazzola et al., 2011).

We can use the mixed methods study design to help assess study validity. Using a concurrent design and analysis of the interviews and surveys creates what Onwuegbuzie and Johnson (2008) refer to as paradigmatic mixing legitimacy (Tashakkori and Teddlie, 1998; Onwuegbuzie and Johnson, 2008). That is, independent analysis of each method is conducted separately and meta-inference allows us to draw legitimate conclusions across both methods. Synthesis of the results after both methods have been completed also insured that the results from one method did not contaminate those from the other. Although the results of the surveys and interviews could have stood on their own, the mixing of results in this analysis provides additional insight into driver distraction that would not have been available had we conducted this research as two independent studies.

5. Conclusions

This research described how distracted driving behavior in truck drivers can be strongly impacted by their supervisors. By enforcing strict policies on distracted driving, supervisors can affect drivers' perceived control and norms surrounding distracted driving – two aspects of the TPB that were correlated with negative distracted driving outcomes. In regression analyses, drivers' intentions towards texting mediated the effects of the other TPB constructs on distraction-involved near crashes; yet their intentions towards dispatch device use did not have the same mediating effects. Thus, targeting drivers' intentions as an intervention on distracted driving could have varying effects, depending on how work-related the given distraction is. By utilizing qualitative and

quantitative methods for data collection and analysis, this study was able to describe how personal and organizational factors affect drivers when deciding whether they should undertake various distracting activities. These results are insightful for how to intervene on different workplace driving distractions for truck drivers.

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