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## **A RESEARCH SYNTHESIS OF TEXT MESSAGING AND DRIVING PERFORMANCE**

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**Summary:** To determine the effects of text messaging on driving performance, all available experimental studies that measured driving performance were identified through a variety of database searches and backtracking strategies, and analyzed using standard research synthesis methods. Fourteen studies with a total of 519 participants were coded and analyzed. Methodology, independent and dependent variables, and statistical analyses varied widely across studies, but conclusions were clear and convergent. Reaction time, crashes, longitudinal and lateral control, eye movements, hazard detection and subjective workload measures indicate significant decrements in driving performance while reading and typing text messages. The importance of the results for further policy development and methodological reporting is briefly introduced.

### **INTRODUCTION**

To many, text messaging while driving is regarded as unsafe. Nevertheless, communicating with friends, family and co-workers may take precedence over attending to driving. In a national U.S. survey, 18 percent of all drivers and 49 percent of those 21 to 24 reported texting and driving (Tison, Chaudhary & Cosgrove, 2011). Surveys of drivers report increasing rates of texting and driving—particularly among young and novice drivers (O'Brien, Goodwin & Foss, 2010). Relatively speaking, the body of research on text messaging while driving has lagged somewhat behind the observed increased volume of texting in recent years. The purpose of this paper is to synthesize the available experimental evidence of the effects of text messaging on driving performance in order to highlight the societal importance of this issue.

A population-based study and a naturalistic study have linked texting while driving to crashes. Wilson and Stimpson (2010) conducted a multivariate regression analysis of the FARS database (Fatality Accident Reporting System, U.S.) and found that the percent of total fatalities from distracted driving increased from 10.9 percent in 1999 to 15.8 percent in 2008. The increase in fatalities from 2002 to 2007 is likely the result of year over year increases in text messaging while driving: the study concluded that an estimated 16,141 additional fatalities resulted from texting while driving for that time period. The media and researchers frequently cite the naturalistic study by Olson and others where a 23 times greater odds of a crash was found for truck drivers who were texting and driving (Olson, Hanowski, Hickman & Bocanegra, 2009). Specifically, texting was found to increase the odds of being involved in crash, near miss or incident for truck drivers (OR = 23.24, 95% CI = 9.69–55.73).

The first paper to address the experimental effects of text messaging on driving performance in passenger vehicles appeared as part of larger set of studies on cell phone use in Sweden (Kircher

et al., 2004); although an earlier study by Tijerina, Kiger, Rockwell and Tarnow (1995) evaluated the effects of reading text messages of different lengths on the driving performance of truck drivers. The first study to focus entirely on text messaging and driving performance was completed by Hosking, Young and Regan (2006) in Melbourne, Australia. Among these and other driving performance studies regarding the effects of text messaging, study methodology varies widely with a diverse set of independent and dependent variables being examined. Given this diversity in study findings, coupled with the emergence of texting as a common practice of everyday life, a systematic review and synthesis of the evidence on the impact of texting on driving performance is warranted, with the aim of improving road safety.

## METHOD

The purpose of a research synthesis is to “integrate empirical research for the purpose of creating generalizations” (Cooper, Hedges & Valentine, 2009, p. 6). The use of meta-analysis, which is a set of statistical procedures that combines effect sizes, was not performed here because of issues in the identified studies including missing *post hoc* comparisons, lack of measurement definitions and insufficient methods descriptions. The steps of a research synthesis, which follow, include indentifying studies, data extraction, coding and thematic analysis (Higgins & Green, 2008).

*Data Sources, Search Strategy and Study Selection.* Using key word variants of driving and text messaging, a number of databases (Google Scholar, PsychINFO, PubMed, SafetyLit, etc.), journals (*Accident Analysis and Prevention, Human Factors, Traffic Injury Prevention, etc.*) proceedings (Driving Assessment, Human Factors and Ergonomics Society, Transportation Research Board, etc.) and government web sites (NHTSA, SWOV, VTI, etc.) were searched for text messaging and driving studies without restriction of date, language, year of publication and source (e.g., article, technical report, proceedings paper, etc.). Backtracking from reference sections was also used to identify additional studies.

*Data Extraction and Coding.* Complete publications were further analyzed to determine whether a study met the established criteria for inclusion. These criteria were first, the study had to measure driving performance, which was defined as controlling a vehicle, simulation or proxy task. Second, study participants had to be driving and reading or writing text messages compared to a baseline control. Texting was defined as reading and/or typing messages as well as associated device manipulation and interface interaction. Two coders extracted measures from all studies and categorization discrepancies were reconciled by discussion.

## RESULTS

*Search Results.* A total of 1,438 abstracts were identified through database search and backtracking strategies. Of these, 1,386 were excluded because they did not focus on driving and text messaging. The remaining 52 complete publications were obtained for further analysis. Careful review resulted in an additional 38 papers being excluded because the focus of study used non-experimental methods including surveys, questionnaires, observations and databases. Two studies did not report sufficient statistical information to be used. Fourteen studies met the inclusion criteria.

*Baseline Characteristics.* Study characteristics and independent variables are listed in Table 1. A number of studies had conditions in addition to texting that were not the focus of this synthesis. For example, the effects of eating as a distraction (Alosco et al., 2012) and text to speech as a potential technological alternative to texting (Owens, McLaughlin & Sudweeks, 2010) were not coded. Only texting conditions were coded.

**Table 1. List of studies, characteristics and independent variables**

Study	Pub. Year	Exp. Setting	N	Participants Sampled Ages and Gender	Independent Variables
1. Alosca et al.	2012	Simulator	143 *	Texting: N = 45, 20.2 Yr., Control: N = 98, 19.9 Yr. T: 76.4% F; C: 56.4% F	Text v. Control
2. Bruge & Chaparro	2012	Simulator	20	Ages: 18 to 55, 10 M, 10 F	Alpha., Copy Text v. Base
3. Crandall & Chaparro	2012	Simulator	23	Ages: 18 to 40 14 M, 9 F	TS, KB v. Base
4. Crisler et al.	2008	Simulator	14	Ages: 18 to 22 7 M, 7 F	Text (word game, conv.) v. Base
5. Drews et al.	2009	Simulator	40	Ages: 19 to 23 20 M, 20 F (20 dyads)	Receive and Send v. Base
6. Hosking et al.	2009	Simulator	20	Ages: 18 to 21 12 M, 8 F	Send, Rec. v. Base
7. Kircher et al.	2004	Simulator	10	Mean Age = 28.7 7 M, 3 F	Read Text Aloud v. Base
8. Leung et al.	2012	Simulator	12	Ages: 23.5 to 30.8 2 M, 10 F	Text v. Base
9. Libby & Chaparro	2009	Simulator	34	Ages: 18 to 58 5 M, 29 F	Text v. CP and VR
10. Owens et al.	2011	Closed Test Track	20	Ages: Y 11, 19 to 34 Old 9, 39 to 51; 11 M, 9 F	Text v. Base; Y/O
11. Ranney et al.	2011	Simulator	100	Ages: 25 to 64 50 M, 50 F	Text v. Other Secondary Tasks
12. Reed & Robbins	2008	Simulator	17	Ages: 17 to 25 8 M, 9 F	Read, Write v. Base
13. Rudin-Brown et al.	2012	Simulator	24	Ages: 25 to 50 12 M, 12 F	Read, Read and Write v. Base
14. Yager et al.	2012	Closed Test Track	42	Ages: 16 & 17, 2, 18 to 35, 32; 35+, 8, 7 M, 25 F	Read, Send v. Base
<b>Totals: 14</b>	2004- 2012	<i>Sim.</i> = 13 <i>Track</i> = 2	519	<i>Age Range: 16 to 72</i> <i>Men 229; Women 290</i>	<i>Send: 12</i> <i>Receive: 5</i>

*Notes.* *Pub.* is publication, *Exp.* is experimental, *N* is number of participants, *Send* is typing a text message, *Rec.* is reading a text message, *M* is male, *F* is female, *Ind.* is independent, *Var.* is variable, *Base* is baseline, *Sim.* is simulator, *Veh.* is vehicle, *Y* is young, *O* is old, *T* is texting, *Conv.* is converse, *CP* is cell phone, *TS* is touch screen, *KB* is keyboard, *VR* is verbal report, *Alpha* is alphabetize, *Str.* is straight. \*Between-subjects groups of texting and control. All other studies used within-subjects experimental designs.

The number of studies reported in the literature from 2004 to present has increased and more so in the past several years (3 in 2011; 6 in 2012). Most studies were performed in simulators of varying types ( $N = 14$ ) and in the U.S. ( $N = 9$ ) in addition to Australia (3), U.K. (1), and Sweden (1). A total of 519 participants from a number of sample groups were represented in the set of studies. Most studies compared sending and/or receiving texting with a control group or a

baseline performance without texting, but one study was included that made comparisons among secondary tasks without reference to baseline driving performance (e.g., Ranney, Baldwin, Parmer, Martin & Mazzae, 2011). For this study, a conservative coding strategy was used that coded a measure only if the texting task was significantly worse than other secondary tasks.

*Dependent Variable Coding.* Dependent variable categories included reaction time (RT), crashes, lateral and longitudinal vehicle control, eye movements, detection and subjective workload (see Caird & Horrey, 2011 for definitions). Within each dependent variable category, variants of each measure were included across studies. For the purposes of showing the overall pattern of results, these variants were collapsed into the categories shown in Table 2. Individual studies could contribute more than one measure per category to significant (\*) or non-significant (ns) counts.

**Table 2. Dependent variable categories for receive and send text messages versus baseline**

Dependent Variable Category	Number of Studies	Receive (Read) v. Baseline	Send (Read, Type) v. Baseline
<b>Reaction Time (RT)</b>	8	3 *+	8 *+, 4 ns
<b>Crashes</b>	2	–	2*+
<b>Lateral Control</b>	13	4 *+, 4 ns	17 *+, 1 ns
<b>Longitudinal Control</b> Speed Speed Variability Headway (t, d) Minimum Headway	7	–	4 *-, 1 *+ 3 *+ 6 *+, 1 ns 1 *-
<b>Eye Movements</b>	4	2 *+, 2 ns	7 *+
<b>Detection</b> Missed Hazards Missed Secondary Tasks Proportion Correct	5	1 *+	4 *+ 1 *+ 1 *-
<b>Subjective Workload</b>	3	1 *+	2 *+, 1 ns

*Notes.* \* indicates a significant difference from baseline, control or other tasks, – indicates a measure that is less than the baseline value, + represents more of a measure than the baseline, ns is not significant.

*Thematic Analysis.* For reaction time (see Table 2 above), participants had slower responses to events in receive and send conditions. However, not all events produced slower responses than baseline in the send condition. Across studies, typing a text while steering affected the lateral control of the vehicle within a lane. Drivers tended to travel slower while typing a text and were more variable while maintaining their speed. Similarly, longer headways were adopted while reading and typing texts. Adopting lower speeds and longer headways while typing texts may or may not compensate for attention being directed away from the roadway. Across studies, participants made more glances away from the roadway while reading and typing texts. Across studies, more hazards and secondary tasks were missed while sending texts.

## DISCUSSION

This research synthesis confirms that text messaging while driving adversely affects numerous measures of driving performance (see Table 2). Overall, drivers in experimental studies showed slower reaction times, a higher number of crashes, greater variability in lateral and longitudinal control, prolonged glances away from the road, more missed hazards, and higher workload while sending text messages and driving. Fewer studies had experimental conditions where reading a text message was separate from writing and/or reading a text and the pattern of results while reading indicated less of an impact on lateral vehicle control and glances away from the road.

This synthesis of driving performance research is convergent with the naturalistic, self-report and epidemiological research on texting and driving (Olson, Hanowski, Hickman & Sudweeks, 2009; Tison, Chaudhary & Cosgrove, 2011; Wilson & Stimpson, 2010). The accumulated evidence across research approaches for the safety costs of text messaging while driving is uniformly negative, unequivocal and convergent. Sending and receiving text messages compromises the safety of the driver, passengers and other motorists and will cause an increasing number of deaths and injuries in the years to come especially if the prevalence of texting continues to escalate.

To prevent this potential future, sending and receiving text messages should be targeted by legislation, enforcement, social norms, parent modeling, peer pressure, blocking technologies, training and education. Currently, 39 states, the District of Columbia, Guam and the Virgin Islands have banned texting and driving and an additional five states limit texting for novice drivers (GHSA, 2012). However, the extent that legislation has or will reduce the frequency of texting and driving behavior may be less than expected (Goodwin et al., 2012). Clearly a multi-method prevention approach will be required.

Methodological and statistical details matter to research synthesis and meta-analysis (Caird, Willness, Steel & Scialfa, 2008). Studies included in this synthesis frequently lacked sufficient methodological and statistical detail. Green (2012) provides a detailed analysis of similar methodological and definitional problems from papers at the first *Automotive UI* conference. In our synthesis, “cell phone” is an insufficient experimental description of the means to send a text message. Over time, cell or smart phones change rapidly and various software and hardware interfaces require complete specification (e.g., t-9, swipe, QWERTY, hard keys, touchscreens, etc.). Interaction constraints affect typing errors and task completion times and thus may also affect driving performance.

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