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Distracted Driving Behaviors and Beliefs among Older Adults

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Abstract

Distracted driving, and especially cell phone use, is a prevalent contributor to crashes. Older drivers have an increased risk of committing safety errors while driving, especially with distraction. The objective of this study was to characterize phone-related distractions in older drivers (age > 65) and identify intervention strategies likely to reduce cell distraction. A 64-question survey was offered online and on paper. A distracted driving scale (DDS) was created by summing responses on 11 distracted driving questions related to phone use (possible score range 0 to 44). Linear regression was performed to identify variables associated with a higher DDS score. A total of 363 older drivers completed the survey; the mean age was 73 and 56% were female. 60% of older adults reported using their cell phone while driving at least some of the time. Participants perceived their own ability as capable or very capable when driving and using: handheld phone (40%); hands-free phone (78%); other tasks (38%) while driving. 32% of older adults who drive minors reported driving while distracted. 30% of those who work felt obligated to take work-related calls. Variables associated with distracted driving include younger age, driving more miles, perceived hands-free skill, smart phone ownership, and being employed or self-employed. State laws and potential loss of insurance coverage with distracted driving were cited as effective penalties. Older adults are engaging in distracted driving, including with minors in the car. Education, state laws, and altering insurance coverage may mitigate this behavior.

In the U.S. in 2015, 3,477 people were killed and about 391,000 were injured due to distracted driving (DD); this accounts for 6.7% of all fatal crashes that year (*1*). DD can take many forms, including talking or texting on a cell phone, reading, using a navigation device, eating or drinking, grooming, interacting with children, and talking to passengers. Research overwhelmingly supports a detrimental relationship between DD and crash risk (*2*).

Of all the forms of DD, cell phone use is especially prevalent in the U.S. and is involved in a sizeable portion of motor vehicle crashes. As of January 2017, 95% of Americans report owning some kind of mobile phone and 77% report owning a smart phone (*3*). In a 2011 study, 69% of users report talking on the phone and 31% report texting or checking email while driving (*4*). This translates to an estimated 6.9% of vehicles whose drivers were using some type of phone (handheld or hands-free) at any typical daylight moment in 2015 (*5*).

Studies find people are four to six times more likely to be involved in a car crash while using a cell phone (*6*, *7*). Though many drivers transition to hands-free in states with restrictive DD laws (*8*), the likelihood of being involved in a motor vehicle collision is not reduced when using a hands-free device (*9*, *10*). The delayed reaction time involved with cell phone usage (both hands-free and handheld) is the equivalent of driving with a blood alcohol content of 0.04–0.12. (*11*, *12*). Other distractions that take eyes, hands and mind off driving have also been shown to increase crash risk, including the use of navigation devices (*13*, *14*), even if they are voice-controlled (*15*).

Despite evidence of the risk of driving distracted, individuals tend to overestimate their driving capabilities. When drivers in one study were asked if talking on the phone or sending messages made a difference in their driving ability, 54% of participants said that talking on a handheld device made no difference, and 25% said texting or sending messages made no difference to their driving performance (*16*). In another study, middle-aged participants rated their abilities to talk while driving as competent or very competent when talking on a handheld phone (52%), hands-free phone (89%) or texting (8%) (*17*).

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Approximately 75% of adults aged 75 and older are active drivers (*18*). While research to date has largely focused on distraction among younger drivers, there is less known about the driving habits of older adults, especially regarding cell phone use. Even without distraction, older drivers are at an increased risk of committing safety errors while driving (*19*) and performed worse than middle-aged drivers when distracted (*20*, *21*).

The effect of distraction mitigation strategies is unclear in this population. In studies of all drivers, restrictive driving laws were associated with decreased overall phone use, while rates of texting remained unchanged (*22*). Other studies show that distraction mitigation strategies, such as the cost of citations, points on the driver's license and insurance-related penalties, may be effective in middle-aged and older populations (*17*, *23*, *24*). More data are needed to understand how older adults distracted drive, how they perceive their behavior, and what methods would most effectively reduce the dangers to older adult drivers.

Two previously published DD surveys conducted by this group's Training, Research and Education for Driving Safety (TREDS) program evaluated driver behavior and attitudes regarding cell phone use among college-aged (*25*) and middle-aged (*17*) adults. In an extension of that work, the objectives of this exploratory study were to examine (*a*) incidence of various phone-related distractions experienced by older adults (age ≥ 65) while driving; (*b*) older adults' beliefs about DD; (*c*) predictors of DD among older adults; and (*d*) potential of specific intervention strategies among older adults to reduce cell phone-related distraction while driving.

Methods

This study and all materials were approved by the Institutional Review Board of the University of California, San Diego.

Survey Development

A DD survey was previously developed and validated in college (*25*) and middle-aged (*17*) populations. The DD survey was modified to target older adults based on expert feedback considering the driving patterns of older adults. The survey focused on five categories of questions: (*a*) demographics, including personal health issues; (*b*) personal cell phone behaviors and observed behaviors of others; (*c*) perceived effectiveness of potential interventions; (*d*) participants' perceived driving ability and ability to multitask; and (*e*) cell phone behavior when driving with minors.

The study was initially piloted with 20 San Diego older adults using a mix of random-sampling and convenience sampling, incentivized with a $20 gift card. The pilot feedback was used to assess face validity and modify the survey accordingly. After edits, additional feedback was obtained with five additional volunteers and the survey was finalized.

Survey Administration

Eligibility criteria required that participants were (*a*) 65 years of age or older, (*b*) using a cell phone at least once a week, (*c*) driving a vehicle at least once a week, (*d*) a U.S. resident, and *e*) English speaking.

The final survey was implemented between May 1 and November 30, 2016. Up to 64 questions were answered, based on skip-logic embedded in the survey. Two reliability questions were included. On average, participants completed the survey in 15 to 20 minutes.

Surveys were completed either online or on paper. Recruitment was done through flyers in participating physician offices, social media, internet posting on the TREDS website, regional newspaper advertisements, and various online and email listservs. Paper surveys were distributed in physician offices in San Diego; participants were given a paper copy of the survey and an addressed stamped envelope to return the survey to research staff. Online participants accessed the survey through Surveymonkey.com. Both surveys included initial eligibility questions, and all participants were invited to participate in an incentive lottery. If interested, participants were directed to complete a second separate survey to provide necessary contact information; no identifying information was linked to survey results.

Measures

Demographics included age, gender, income, ethnicity, employment status, living location, marital status, and cell phone ownership. Respondents were also asked to report common health conditions, with a focus on conditions that may impact driving performance. Finally, participants were asked to rate their quality of day and night vision.

Survey questions also assessed the frequency of selected driving behaviors and attitudes, including behaviors around DD; when feasible these questions were measured with Likert-scale response options. Based on existing research as well as the expertise of the authors, questions were designed to explore multiple facets of DD.

From the survey, a 12-item distracted driving scale (DDS) was created by summing responses on DD questions in terms of frequency of behavior (Table 1). For example, "How much time do you spend talking on a handheld cell phone?" had five Likert-scale response options (0 = never, 1 = rarely, 2 = sometimes, 3 = often, 4 = frequently). The DDS was based on items used in the survey of middle-aged adults (*17*).

Data Analysis

Analyses were run in SPSS v. 22.0 and R v. 3.3.2 using a *p*-value of .05 to determine significance. An exploratory factor analysis was conducted to determine if the scale had multiple factors (e.g., hypothesized texting behaviors vs. talking behaviors). One DDS question was found to have a borderline

Table 1. 12-item DDS[a]

DD1: Of the time that you spend driving on an average day, how much time do you spend talking on a HANDHELD cell phone?
DD2: Of the time that you spend driving on an average day, how much time do you spend using a HANDS-FREE device with your cell phone?
DD3: Of the time that you spend driving on an average day, how much time do you spend TEXTING with your cell phone?
DD4: How often do you talk on a cell phone (handheld or hands-free) while driving with passengers age 11 years old or younger?[b]
DD5: How often do you TEXT while driving with passengers age 11 years old or younger?[b]
DD6: How often do you talk on a cell phone (HANDHELD or HANDS-FREE) while driving with passengers between the ages of 12–17 years?[b]
DD7: How often do you TEXT while driving with passengers between the ages of 12–17 years?[b]
DD8–12: While driving, how frequently do you use these devices while the vehicle is moving?
DD8: Navigation device (e.g., TomTom, Garmin, smartphone map application)
DD9: Portable music player (e.g., iPod)
DD10: Laptop/Tablet
DD11: Smartphone applications (e.g., games, email, music)
DD12: Other electronic devices[c]

[a]Answer options: 0= never (only emergency/911 calls); 1= rarely (less than 10% of the time); 2= sometimes (about 25% of the time); 3= often (about 50% of the time); 4= frequently (greater than 75% of the time).
[b]Only includes participants who reported driving with minor passengers.
[c]This question was removed from final analysis.

loading (0.349) and communality (0.12); when removed, the eigenvalue dropped from 6.60 to 6.50 but the amount of variance explained increased from 55% to 59%. Based on these results, the last DDS question ("other electronic devices") was excluded from further analysis.

The final 11-point DDS had a possible score range of 0 to 44. Initial analysis included descriptions of participant characteristics, frequency of engaging in different DD behaviors, and frequency of attitudes and beliefs pertaining to DD. Chi-squared tests and one-sided Wilcox Rank-Sum tests were performed to determine the association between DD scores of ≥1 and various self-reported health conditions.

A linear regression model was run in R where the DDS was the outcome; the full model included demographic variables and expected correlates of DD behaviors. The following measures were considered in the regression analysis: age, ethnicity, income, smartphone ownership, employment status, days driving per week, time spent driving per day, perceived hands-free skill, perceived ability to multitask while driving, perceived ability to drive safely compared to other drivers, and perceived skill at driving safely while using a handheld phone or texting.

While each individual question in the DDS is ordinal, the scale was treated as continuous. Because the DDS scores were right-skewed, the data were transformed using square root of sum to improve the quality of the analysis to better approximate a normal distribution for analysis while providing interpretable estimates. The appropriateness of this method was confirmed by running a bivariate analysis and plotting the response variables in a histogram. Variables of interest, as outlined above, were identified and tested via a step function in R to identify significant predictors for the regression model, and variables that did not significantly contribute to the DDS model were excluded. Following analysis, diagnostic plots were created to ensure the validity of the linear regression. Logistic regression was also performed with similar results, using DDS = 0 versus >1.

Results

A total of 397 participants accessed the survey and 363 (91.4%) met eligibility requirements. Of those who were ineligible, six (17%) were under 65, twenty-six (77%) used a cell phone less than once per week, and two (6%) were not U.S. residents. More than 90% of surveys were completed online.

Participant Characteristics

Descriptive participant information is summarized in Table 2.

Respondents were 56% female, 87% white non-Hispanic, and the mean age was 73, with a range of 65 to 94 years. Almost 24% reported an income level under $50,000 per year, and 25% reported being currently employed or self-employed. 83% were smartphone owners. Of note, not all participants chose to answer demographic information; approximately 90% of respondents answered each demographic question with the exception of medical conditions, which was answered by only 62% of respondents. Over half of those answering reported at least one medical condition (e.g., arthritis (50%), high blood pressure (47%), diabetes (16%)), which could potentially affect one's driving ability. Several participants listed medical conditions that impair vision, including glaucoma (4%) and/or macular degeneration (4%). About 2% reported a diagnosis of dementia, Parkinson's or stroke. While all respondents reported at least fair day vision for driving, 7% reported poor or somewhat poor night vision for driving.

Table 2. Participant Descriptives

	N(%)/mean(SD)
Gender (*n* = 339)	
Male	147 (43.4%)
Female	192 (56.6)
Ethnicity (*n* = 322)	
White	283 (87.9%)
Hispanic	18 (5.6)
Other	21 (6.5)
Income (*n* = 267)	
Less than $50,000	63 (23.6%)
$50,000–$99,999	93 (34.8)
$100,000–$149,999	66 (24.7)
$150,000 or more	45 (16.9)
Smartphone owner (*n* = 344)	285 (82.8%)
Employment status (*n* = 348)	
Employed	64 (18.4%)
Not employed	259 (74.4)
Self employed	25 (7.2)
Living location (*n* = 335)	
Single family home	263 (78.5%)
Condominium/apartment	40 (11.9)
Senior residential community	27 (8.1)
Other	5 (1.5)
Marital status (*n* = 337)	
Single	26 (7.7%)
Married/domestic partnership	201 (59.6)
Widowed	62 (18.4)
Divorced	48 (14.2)
Age	
All (*n* = 331, range 65–94 years)	73.1 (6.6)
Female (*n* = 189, 65–89)	72.4 (6.2)
Male (*n* = 142, 65–94)	74.1 (7.1)
Medical conditions (*n* = 226)	
Arthritis	113 (50.0%)
High blood pressure	108 (47.8)
Diabetes	37 (16.4)
Cancer (in the last 2 years)	24 (10.6)
Heart disease	19 (8.4)
Depression	16 (7.1)
Glaucoma	15 (6.6)
Macular degeneration	14 (6.2)
Parkinson's disease	3 (1.3)
Stroke	3 (1.3)
Dementia	2 (0.9)
Epilepsy	1 (0.4)
Quality of day vision (*n* = 334)[a]	4.58 (0.6)
Quality of night vision (*n* = 331)[a]	3.70 (0.9)

[a]Range 1 (poor) – 5 (excellent).

Behavior and Attitudes

The driving behaviors and attitudes of participants are summarized in Table 3.

Participants were generally active drivers, driving an average of nearly 6 days per week and 3 round trips per day. 44% of participants drove more than 50 miles per week. 82% of participants owned a smartphone. All but one participant used their smartphone for talking, though many used their smartphone for other capabilities (i.e., texting [78%], email [64%], browsing internet [56%], navigation [54%], and music [24%]).

Nearly 60% of respondents reported using their phone while driving, including 42% who talk (hands-free or handheld) and 9% who text while driving. 61% of participants use their phone for navigation while driving at least rarely, and 11% of participants use it often or frequently.

When asked about incoming calls, 42% of participants reported that they do not answer calls while driving. The remaining 58% reported accepting calls in at least some capacity while driving: almost 10% tell their caller that they will call right back, 12% reported that they pull over after answering, 12% answer only when they recognize the caller, and 23% answer all calls. Of the participants who take all calls, 35% specifically mentioned a hands-free function in the comment section. Of those who were employed, nearly 30% felt obligated to take work-related calls while driving.

When asked about outgoing calls, 39% of participants make outgoing calls while driving. Of those, 45% are using voice commands on their phone or in the car. The remainder reported using their hands to scroll through their contacts list, use speed dial, or manually enter numbers when they are placing calls.

In addition to using their phone while driving alone or with other adults, participants also engage in these behaviors while driving with minor passengers. A total of 26% of participants reported driving with a minor in the car. Of those who drive with minors, 33% of participants reported using their phone either hands-free or handheld while driving with younger children (under age 11) and about 42% when driving with older children (aged 12 to 17). Though less common, about 1% reported texting when driving minors (regardless of age). 87% reported the minors were their grandchildren.

Participants rated their own driving abilities highly; almost 80% reported that they drive better than their peers. Participants also perceived their own ability as capable or very capable when driving and using a handheld phone (40%), a hands-free phone (78%), or doing other tasks while driving (38%).

Citations and Crashes

The survey included questions about adverse driving events, including citations and crashes. About 18% of participants were involved in collisions in the last 2 years, and 43% were given a non-parking citation in the last 2 years. Though only 10 respondents had received a ticket for talking on the phone

Table 3. Knowledge and Behaviors

Driving knowledge and behavior	
	N(%)/mean(SD)
Number of years driving (*n* = 326)	56.20 (7.7)
Number of days a week driving (*n* = 344)	5.78 (1.4)
Time spent driving per day (*n* = 345)	0.81 (0.5)
What do you do with your smartphone (*n* = 348)	
Talk	347 (99.7%)
Text	274 (78.7)
GPS/navigation	191 (54.9)
Bluetooth	150 (43.1)
Phone "apps"	186 (53.5)
Email	224 (64.4)
Music	84 (24.1)
Podcasts	49 (14.1)
Browse internet	198 (56.9)
Primary purpose of phone use while driving (*n* = 344)	
Personal	150 (43.5%)
Work-related	19 (5.5)
Critical information (directions, etc.)	24 (7.0)
I never use the phone while driving	143 (40.6)
Other	9 (2.6)
What do you do when the phone rings (*n* = 344)	
Answer; pull over	42 (12.2%)
Answer; tell the caller you will call back	34 (9.9)
Answer; take the call	79 (23.0)
Answer only if recognized number	41 (11.9)
Don't answer	147 (42.7)
Other ("it depends")	1 (0.3)
How do you make calls while driving (*n* = 358)	
Manually enter numbers	14 (3.9%)
Speed-dial	37 (10.3)
Scroll through contact list/saved numbers	26 (7.6)
Voice-dial	65 (18.2)
I don't place calls while driving	216 (62.1)
Does your employer have policies in place about cell use while driving (*n* = 64)	
Yes	19 (29.7%)
No	20 (31.3)
Don't Know	25 (39.1)
Do you feel obligated to take work-related calls when driving (*n* = 64)	
Yes	19 (29.7%)
No	45 (70.3)
Driving with minors in the car (in past month)	
Driving minors under aged 11 (*n* = 343)	
Yes	92 (26.8%)
No	251 (73.2)
Driving minors aged 12–17 (*n* = 336)	
Yes	59 (17.6%)
No	277 (82.4)
Talking while driving minors under age 11 (*n* = 91)	
Never (only emergency/911 calls)	61 (67.1%)
Rarely (less than 10% of time)	27 (29.6)
Sometimes (25% of time)	1 (1.1)
Often (50% of time)	2 (2.2)
Frequently (greater than 75% of the time)	0 (0)

(*continued*)

Table 3. (continued)

Driving knowledge and behavior	
	N(%)/mean(SD)
Texting while driving with minors under age 11 (*n* = 89)	
Never (only emergency/911 calls)	86 (96.7%)
Rarely (less than 10% of time)	1 (1.1)
Sometimes (25% of time)	2 (2.2)
Often (50% of time)	0 (0)
Frequently (greater than 75% of the time)	0 (0)
Talking while driving minors ages 12–17 (*n* = 59)	
Never (only emergency/911 calls)	34(57.6%)
Rarely (less than 10% of time)	23 (39.0)
Sometimes (25% of time)	2 (3.4)
Often (50% of time)	0 (0)
Frequently (greater than 75% of the time)	0 (0)
Texting while driving with minors ages 12–17 (*n* = 59)	
Never (only emergency/911 calls)	54 (91.53%)
Rarely (less than 10% of time)	3 (5.1)
Sometimes (25% of time)	2 (3.4)
Often (50% of time)	0 (0)
Frequently (greater than 75% of the time)	0 (0)
Relationship with minors under age 11 (*n* = 89)	
Parent	2 (2.22%)
Grandparent	79 (87.8)
Other relative	3 (3.3)
Caregiver	1 (1.1)
Family friend	4 (4.4)
Relationship with minors ages 12–17 (*n* = 59)	
Parent	2 (3.4%)
Grandparent	44 (74.6)
Other relative	6 (10.2)
Caregiver	0 (0)
Family friend	7 (11.9)
Perceived abilities	
Ability to drive safely (*n* = 346)	
Much worse than others	0 (0%)
Somewhat worse than others	1 (0.3)
About the same as others	72 (20.8)
Somewhat better than others	119 (34.3)
Much better than others	154 (44.4)
Unsure	1 (0.3)
Ability to perform other tasks while driving (*n* = 342)	
1 (poor)	36 (10.5%)
2	40 (11.7)
3 (fair)	136 (39.8)
4	106 (31.0)
5 (excellent)	24 (7.0)
To what extent are you capable of:	
Driving safely while using handheld phone[a] (*n* = 344)	2.5 (1.1)
Driving safely while using handsfree phone[a] (*n* = 327)	3.6 (1.6)
Driving safely while texting[a] (*n* = 338)	1.4 (0.7)
Personal punitive history, knowledge, and attitudes	
How many times in the last 2 years have you been pulled over (*n* = 346)	
0	309 (89.31%)
1	35 (10.1)
2+	2 (0.6)

(*continued*)

Table 3. (continued)

Driving knowledge and behavior	
	N(%)/mean(SD)
Number of collisions in the last 2 years, regardless of fault (*n* = 346)	
0	281 (81.2%)
1	57 (16.5)
2+	8 (2.3)
Ever received ticket for phone use (*n* = 345)	
Yes	10 (2.9%)
No	335 (97.1)
Knowledge about state laws (*n* = 346)	
Not knowledgeable	6 (1.7%)
Somewhat knowledgeable	101 (29.2)
Very knowledgeable	231 (66.8)
I am not aware if my state has cell phone laws	8 (2.3)
My state does not have cell phone laws	0 (0)
Has your state cell phone law changed your driving behavior (*n* = 329)	
1 (not at all)	112 (34.0%)
2	21 (9.4)
3 (somewhat)	65 (19.8)
4	43 (13.1)
5 (significantly)	78 (23.7)
Which penalty would be effective in stopping this behavior? (*n* = 346)[b]	
Insurance would not cover crashed involving handheld cell phone use	4.1 (1.2)
Receiving a citation for handheld cell phone use would result in a point on your driving record	3.9 (1.2)

[a]1 (not capable at all) – 5 (very capable).
[b]1 (not effective) – 5 (very effective).

Table 4. Stepwise Linear Regression Table of Significant Coefficients

	B estimate	Std. error	*p*-value
Intercept	1.2963	0.7318	0.0776
Age	–0.0307	0.0143	0.0327
Number of years driving	0.0107	0.0120	0.3699
Gender (male)	0.1856	0.1047	0.0775
Number of days driving per week	0.0740	0.0372	0.0477
Smartphone ownership (yes)	0.6129	0.1376	0.0000
Perceived skill driving using phone hands-free	0.1880	0.0450	0.0000
Employed (vs. not employed)	0.7562	0.1829	0.0000
Self-employed (vs. not employed)	0.2982	0.1396	0.0335

while driving, all these drivers reported that they changed their behavior or stopped using their cell phone after the citation. Nearly 96% of participants reported feeling somewhat or very familiar with their state laws regarding cell phone calls, and 56% stated that the cell phone laws had changed their driving behaviors.

Participants were asked about hypothetical penalties for DD. 70% reported that if insurance companies did not cover crashes related to handheld cell phone use, it would be effective in changing their behavior. Similarly, 65% reported that the penalty of points on the driver's license for use of a handheld phone would be effective in changing their behavior.

DDS Outcomes and Linear Regression Models

The DDS was used to determine predictive variables for DD among the participants. Though the 11-item DDS had a possible score range of 0 to 44, the actual score ranged from 0 to 22 points among participants. The mean was about 3 points.

For all DDS questions, "never" was the most frequently selected answer. There was a high correlation between questions; participants who answered any one question with a non-zero response (endorsing any distracted behavior) were more likely to answer other questions with a non-zero response. The most commonly reported DD behaviors were questions DDS2: use of hands-free phone (51%), and DDS8: use of navigation tools (61%).

The linear regression model contained the following significant predictors (Table 4): age ($p = 0.0327$), days driving per week ($p = 0.0477$), smartphone ownership ($p < 0.0001$), perceived hands-free skill ($p < 0.0001$), and whether the driver is employed ($p < 0.0001$) or self-employed ($p = 0.0335$). Measures which did not contribute and were excluded from the final linear regression model included ethnicity, income, time spent driving per day, perceived ability to multitask while driving, perceived ability to drive safely compared to other drivers, and perceived skill at driving safely while using a handheld phone or texting.

A secondary analysis was done to include participants' medical history. Medical conditions were not significant predictors of a higher DDS score. Given this finding and a low response rate for these questions, medical conditions were also not included in the final regression model.

Discussion of Results

Despite the common perception that DD is only a problem among teens and younger adults, older adults were also found to engage in DD in this study, and interventions should include this population. Overall, cell phone use while driving was common in our study participants, as nearly 60% use their phone in some way while driving, including answering calls, making calls, and texting. Over 80% of respondents own a smartphone, which was associated with self-reported DD. Younger age, driving more miles, perceived hands-free skill, and being employed or self-employed were also associated with DD behaviors. These factors associated with higher DDS scores and riskier behaviors can inform whom to target with future interventions.

When compared with participants in the partner studies of college students (*25*) and middle-aged adults (*17*), older adults reported taking greater precautions and less frequent cell phone use while driving. Yet, most of the older drivers sampled in this study still reported DD due to cell phone use. They also reported high rates of concurrent medical conditions, including conditions that impact baseline driving abilities, though this was not significantly associated with DD behavior.

Consistent with prior studies of other age groups (*26*), the older adults reported high levels of confidence in their own driving abilities. In addition to reporting being better drivers than their peers, many older adult participants perceived their own driving ability as good or excellent even while driving distracted; this suggests that they fail to recognize the impact of DD on their driving safety. Though not directly measured, many of the participants commented on the use of functions in their car to assist with making or receiving calls, including pressing buttons on the display or steering wheel, looking at the display to see caller ID, scrolling contacts, or using navigation assistance. Though users often don't recognize these activities as DD, each require cognitive distraction, and many require the driver to take their eyes off the road. The use of navigation devices, even when pre-programmed, requires at least inattention from the task of driving, and may involve manual distraction as well (for example, when users pick up their phones to look at the screen) (*13–15*).

The survey additionally explored two specific behaviors: driving with minors, and work-related DD. Driving with minors in the car not only contributes to distraction (*27*, *28*), and models bad driving behavior for the minors (*29*, *30*), but the increased risk of crash from any DD is also putting the minor passengers at risk of injury. Nearly one in twelve participants reported using their phone while driving with younger children (<11 years old), usually their grandchildren. This unique group could benefit from targeted interventions; parents should also be encouraged to discuss safe driving with their family caretakers.

Another concerning finding was the frequency of work-related DD. 30% of employed (including self-employed) participants reported feeling obligated to take work-related calls while driving. The results from the final stepwise linear regression model showed that being self-employed or employed was a significant predictor of DD when compared to those who are not employed. This finding suggests that work needs to be done with employers, and those who are self-employed also need to be targeted and encouraged to develop clear and safe cell phone policies.

A variety of possible interventions were explored in this survey to gauge older adults' receptivity and perceived effectiveness of the interventions. The responses lend support for state laws that target driving behaviors, as over half of participants reported changing their behavior in response to laws. Respondents who previously received a citation for DD unanimously reported changing their behavior to follow the laws (i.e., hands-free), and many stopped using their phone while driving completely, though this was only a small subsample of our population (10 respondents). In terms of possible future interventions, approximately 90% of respondents stated that insurance policy changes or points on their license would at least somewhat change their behavior. Each of these potential interventions may provide an avenue to reduce DD among older adults, whether through stricter

laws, increased enforcement, or punitive measures related to insurance.

In addition to these punitive measures, there are other possible mitigating strategies for behavior change. Existing education programs are offered to increase awareness about the dangers of DD. One example is the *Just Drive* class offered through the TREDS program at the University of California, San Diego. The *Just Drive* class encourages participants to be safe and responsible drivers, and targets employees. This curriculum could be modified and target other populations of older drivers, including those who are self-employed, to develop a personal culture of safety. Finally, healthcare providers could play a role; not only can providers assess risk related to concurrent medical conditions, but utilization of a simplified DDS may help identify distracted drivers who can benefit from intervention.

The authors acknowledge some limitations of this study. The study respondents were primarily White non-Hispanic, female, and in a higher income bracket than what would be representative of California. Most participants completed the survey online, which indicates the sample population may be skewed to those who have access to computers, are tech-savvy, and more likely to have smartphones. Future studies should target a more diverse population and offer materials in other languages. To target a more driving-active population, the authors chose to limit eligibility to older adults who use their cellphone at least once a week, and who drive at least once per week. Previous studies have suggested that infrequent older drivers may have higher crash risk (*31*); future studies may choose to further study this other high-risk population.

The survey was also self-reported, which may result in under-reporting of undesirable behaviors (i.e., social desirability bias), and participants were likely reluctant to admit that they use electronics while driving. The completely anonymous design of the data collection may limit some of this bias, as there was no identifying information collected. Although large side-of-road observational studies (*32*, *33*), and naturalistic driving studies using in-car monitoring systems (*34–36*) can objectively examine DD behaviors and avoid this bias, surveys such as done in this study that rely on self-reported data are less expensive and allow for large sample sizes. Additionally, this survey format allows for exploration of older adult drivers' perceptions of their own driving behavior. Future studies may consider using real-time video recordings of drivers, with concurrent use of self-reported behavior surveys; this dual technology and survey-based study could be used to validate the DDS. Finally, the results were not normally distributed because many participants reported that they never used any electronics while driving. As a cross-sectional study, variables that were associated with higher scores (i.e., predictors) were identified but conclusions about causality cannot be made.

Conclusions

With cell phones nearly ubiquitous in the U.S., prevention of cell phone use while driving is a worrisome public health and safety issue. Older drivers are a growing population that is engaging in high-risk behavior, even with medical conditions and with minors in the car. Older drivers also overestimate their driving skills and their ability to drive well while distracted. Interventions such as education, employer programs, citations, points on their driver's license, and insurance changes with DD-related crashes may mitigate these behaviors, but more studies are needed. Routine screening and education of the public may also help reduce the number of distracted drivers. These results can guide program and policy changes that could improve safety on California's roads and across the nation.

Author Contributions

The authors confirm contribution to the paper as follows: study conception and design: Hill, Rybar, Jahna; data collection: Hill, Alwahab, Chukwueke, Engler; analysis and interpretation of results: Hill, Baird, Engelberg, Larocca; draft manuscript preparation: Hill, Baird, Engler, Jahns, Rybar, Engelberg. All authors reviewed the results and approved the final version of the manuscript.

References

1. *Traffic Safety Facts 2015: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*. Publication DOT HS 812 384. NHTSA, U.S. Department of Transportation, Washington, D.C., 2017.
2. Ferdinand, A. O., and N. Menachemi. Associations Between Driving Performance and Engaging in Secondary Tasks: A Systematic Review. *American Journal of Public Health*, Vol. 104, No. 3, 2014, pp. e39–e48. http://doi.org/10.2105/ajph.2013.301750.
3. *Mobile Fact Sheet*. Pew Research Center, January 12, 2017. http://www.pewinternet.org/fact-sheet/mobile/. Accessed June 11, 2017.
4. Mobile Device Use While Driving–United States and Seven European Countries, 2011. *Morbidity and Mortality Weekly Report*. Vol. 62, No. 10, 2013, pp. 177–182.
5. Pickrell, T. M., R. Li, and S. KC. *Driver Electronic Device Use in 2015*. Publication DOT HS 812 326. NHTSA, U.S. Department of Transportation, Washington, D.C., 2016.
6. McEvoy, S. P., M. R. Stevenson, A. T. McCartt, M. Woodward, C. Haworth, P. Palamara, and R. Cercarelli. Role of Mobile Phones in Motor Vehicle Crashes Resulting in Hospital Attendance: A Case-crossover Study. *BMJ*. Vol. 331, No. 7514, 2005, pp. 428. http://doi.org/10.1136/bmj.38537.397512.55.
7. Redelmeier, D. A., and R. J. Tibshirani. Association Between Cellular-telephone Calls and Motor Vehicle Collisions. *New England Journal of Medicine*. Vol. 336, No. 7, 1997, pp. 453–458. http://doi.org/10.1056/nejm199702133360701.
8. Braitman, K. A., and A. T. McCartt. National Reported Patterns of Driver Cell Phone Use in the United States. *Traffic Injury*

Prevention. Vol. 11, No. 6, 2010, pp. 543–548. http://doi.org/10.1080/15389588.2010.504247.

9. McEvoy, S. P., M. R. Stevenson, and M. Woodward. The Contribution of Passengers Versus Mobile Phone Use to Motor Vehicle Crashes Resulting in Hospital Attendance by the Driver. *Accident Analysis and Prevention*, Vol. 39, 2007, pp. 1170–1176. http://doi.org.10.1016/j.aap.2007.03.004.
10. Ishigami, Y., and R. M. Klein. Is a Hands-free Phone Safer Than a Handheld Phone? *Journal of Safety Research*, Vol. 40, No. 2, 2009, pp. 157–164. http://doi.org/10/1016/j.jsr.2009.02.006.
11. Leung, S., R. J. Croft, M. L. Jackson, M. E. Howard, and R. J. McKenzie. A Comparison of the Effect of Mobile Phone Use and Alcohol Consumption on Driving Simulation Performance. *Traffic Injury Prevention*, Vol. 13, No. 6, 2012, pp. 566–574. http://doi.org/10.1080/15389588.2012.683118.
12. Strayer, D. L., F. A. Drews, and D. J. Crouch. A Comparison of the Cell Phone Driver and The Drunk Driver. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, Vol. 48, No. 2, 2006, pp. 381–391. http://doi.org/10.1518/001872006777724471.
13. Knapper, A., N. Van Nes, M. Christoph, M. Hagenzieker, and K. Brookhuis. The Use of Navigation Systems in Naturalistic Driving. *Traffic Injury Prevention*, Vol. 17, No. 3, 2016, pp. 264–270. https://doi.org/10.1080/15389588.2015.1077384.
14. Stimpson, J. P., F. A. Wilson, and R. L. Muelleman. Fatalities of Pedestrians, Bicycle Riders, and Motorists Due to Distracted Driving Motor Vehicle Crashes in the U.S., 2005-2010. *Public Health Reports*, Vol. 128, No. 6, 2013, pp. 436–442. https://doi.org/10.1177/003335491312800603.
15. Strayer, D. L., J. M. Cooper, J. Turrill, J. R. Coleman, and R. J. Hopman. Talking to Your Car Can Drive You to Distraction. *Cognitive Research: Principles and Implications*, Vol. 1, No. 1, 2016, pp. 16. https://doi.org/10.1186/s41235-016-0018-3.
16. Tison, J., N. Chaudhary, and L. Cosgrove. *National Phone Survey on Distracted Driving Attitudes and Behaviors*. Publication DOT HS 811 555. NHTSA, U.S. Department of Transportation, Washington, D.C., 2011.
17. Engelberg, J., L. Hill, J. Rybar, and T. Styer. Distracted Driving Behaviors Related to Cell Phone Use among Middle-Aged Adults. *Journal of Transport and Health*. Vol. 2, No. 3, 2015, pp. 434–440. http://doi.org/10.1016/j/jth.2015.05.002.
18. Betz, M. E., and S. R. Lowenstein. Driving Patterns of Older Adults: Results from the Second Injury Control and Risk Survey. *Journal of the American Geriatrics Society*, Vol. 58, No. 10, 2010, pp.1931–1935. http://doi.org/10.1111/j.1532-5415/2010/03010.x.
19. Dawson, J., E. Y. Uc, S. Anderson, A. M. Johnson, and M. Rizzo. Neuropsychological Predictors of Driving Errors in Older Adults. *Journal of the American Geriatrics Society*, Vol. 58, No. 6, 2010, pp. 1090–1096. http://doi.org/10.1111/j.1532-5415.2010.02872.x.
20. Strayer, D. L., and F. A. Drews. Profiles in Driver Distraction: Effects of Cell Phone Conversations on Younger and Older Drivers. *Human Factors*, Vol. 46, No. 4, 2004, pp. 640–649. http://doi.org/10.1518/fjes.46.4.640.56806.
21. Thompson, K. R., A. M. Johnson, J. L. Emerson, J. D. Dawson, E. R. Boer, and M. Rizzo. Distracted Driving in Elderly and Middle-aged Drivers. *Accident Analysis & Prevention*, Vol. 45, 2013, pp. 711–717. http://doi.org/10/1016/j.aap.2011.09.040.
22. Braitman, K., and A. McCartt. National Reported Patterns of Driver Cell Phone Use in the United States. *Traffic Injury Prevention*, Vol. 11, No. 6, 2010, pp. 543–548. http://doi.org/10.1080/15389588.2010.504247.
23. Donmez, B., L. N. Boyle, and J. D. Lee. The Impact of Distraction Mitigation Strategies on Driving Performance. *Human Factors*, Vol. 48, No. 4, 2006, pp. 485–804. http://doi.org/10.1518/001872006779166415.
24. Eby, D. W., L. J. Molnar, J. T. Shope, J. M. Vivoda, and T. A. Fordye. Improving Older Driver Knowledge and Self-awareness Through Self-assessment: The Driving Decisions Workbook. *Journal of Safety Research*, Vol. 34, No. 3, 2003, pp. 371–381. http://doi.org/10.1016/j.jsr.2003.09.006.
25. Hill, L., J. Rybar, T. Styer, E. Fram, G. Merchant, and A. Eastman. Distracted Driving Prevalence and Attitudes in College and University Students. *Traffic Injury Prevention*, Vol. 16, No. 4, 2015, pp. 362–367. http://doi.org/10.1080/15389588.2014.949340.1080/15389588.2014.949340.
26. Allstate Insurance Company. *New Allstate Survey Shows Americans Think They Are Great Drivers – Habits Tell a Different Story*. PRNewswire, August, 2011. https://www.prnewswire.com/news-releases/new-allstate-survey-shows-americans-think-they-are-great-drivers–habits-tell-a-different-story-126563103.html. Accessed November 2, 2017.
27. Roney, L., P. Violano, G. Klaus, R. Lofthouse, and J. Dziura. Distracted Driving Behaviors of Adults While Children are in the Car. *Journal of Trauma and Acute Care Surgery*, Vol. 75, No. 4, Suppl 3, 2013, pp. S290–S295. http://doi.org/10/1097/TA.0b013e3182924200.
28. Massey, K., S. Kant, P. Violano, L. Roney, W. King, W. Justice, K. Mcfalls, and K. Monroe. Evaluating Distracted Driving Behaviors in Parents of Children in Suburban and Rural Areas of Alabama. *Journal of Trauma and Acute Care Surgery*, Vol. 80, No. 4, Suppl 1, 2016, pp. S44–S47. https://doi.org/10.1097/TA.0000000000001181.
29. Bianchi, A., and H. Summala. The "Genetics" of Driving Behavior: Parents' Driving Style Predicts Their Children's Driving Style. *Accident; Analysis and Prevention*, Vol. 36, No. 4, 2004, pp. 655–659. https://doi.org/10.1016/S0001-4575(03)00087-3.
30. Taubman-Ben-Ari, O., O. Musicant, T. Lotan, and H. Farah. The Contribution of Parents' Driving Behavior, Family Climate for Road Safety, and Parent-targeted Intervention to Young Male Driving Behavior. *Accident; Analysis and Prevention*, Vol. 72, 2014, pp. 296–301. https://doi.org/10.1016/j.aap.2014.07.010.
31. Langford, J., J. L. Charlton, S. Koppel, A. Myers, H. Tuokko, S. Marshall, M. Man-Son-Hing, P. Darzins, M. Di Stefano, and W. Macdonald. Findings from the Candrive/Ozcandrive Study: Low Mileage Older Drivers, Crash Risk and Reduced Fitness to Drive. *Accident Analysis & Prevention*, Vol. 61, 2013, pp. 304–310. https://doi.org/10.1016/j.aap.2013.02.006.
32. Torkamannejad Sabzevari, J., A. R. Nabipour, N. Khanjani, A. Molaei Tajkooh, and M. J. M. Sullman. An Observational Study of Secondary Task Engagement While Driving on Urban Streets in Iranian Safe Communities. *Accident; Analysis and Prevention*, Vol. 96, 2016, pp. 56–63. https://doi.org/10.1016/j.aap.2016.07.020.
33. *Distracted Driving in Washington State, 2016: An Observational Survey*. Washington Traffic Safety Commission, 2017. http://wtsc.wa.gov/wp-content/uploads/2017/01/2016-DD-REPORT.pdf.

34. Marshall, S. C., M. Man-Son-Hing, J. Charlton, L. J. Molnar, S. Koppel, and D. W. Eby. The Candrive/Ozcandrive Prospective Older Driver Study: Methodology and Early Study Findings. *Accident Analysis & Prevention*, Vol. 61, 2013, pp. 233–235. https://doi.org/10.1016/j.aap.2013.07.007.
35. Li, G., D. W. Eby, R. Santos, T. J. Mielenz, L. J. Molnar, D. Strogatz, M. E. Betz, C. DiGuiseppi, L. H. Ryan, V. Jones, and S. I. Pitts. Longitudinal Research on Aging Drivers (LongROAD): Study Design and Methods. *Injury Epidemiology*, Vol. 4, No. 1, 2017, pp. 22. https://doi.org/10.1186/s40621-017-0121-z.
36. Dingus, T. A., S. G. Klauer, V. L. Neale, A. Petersen, S. Lee, J. D. Sudweeks, M. A. Perez, J. Hankey, D. J. Ramsey, and S. Gupta. *The 100-Car Naturalistic Driving Study, Phase II – Results of the 100-Car Field Experiment*. Publication DOT HS 810 593. NHTSA, U.S. Department of Transportation, Washington, D.C., 2006.

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