



SUMMARYREPORT

COMPARATIVE EFFECTIVENESS OF ALTERNATIVE SMARTPHONE-BASED NUDGES TO REDUCE CELLPHONE USE WHILE DRIVING: FINAL REPORT

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**FHWA Contact: James Pol, HRD T-210, (202) 493-3371,
James.Pol@dot.gov.**

**Researchers: Jeffrey Ebert^{1,2,3}; Aria Xiong^{1,2,3}; Scott Halpern³;
Flaura Winston⁴; Catherine McDonald^{2,4}; Roy Rosin³;
Kevin Volpp³; Ian Barnett²; Dylan Small²; Douglas
Wiebe²; Dina Abdel-Rahman^{1,2,3}; Jessica Hemmons^{1,2,3};
Rafi Finegold⁵; Ben Kotrc⁵; Emma Radford⁵; William Fisher⁶;
Kristen Gaba⁶; William Everett⁶.**

**Principal Investigator: M. Kit Delgado^{1,2,3,4}
mucio.delgado@pennmedicine.upenn.edu.**

From the: (1) Behavioral Science and Analytics For Injury Reduction Lab, (2) the Penn Injury Science Center, and the (3) Center for Health Incentives and Behavioral Economics, University of Pennsylvania, (4) the Center for Injury Research and Prevention, Children's Hospital of Philadelphia, (5) TrueMotion, Inc., and (6) The Progressive Corporation.

Note: All authors contributed to both randomized control trials except for Finegold, Kotrc, and Radford, who contributed to trial no.1 only.

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U.S. Department of Transportation
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Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

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EXECUTIVE SUMMARY

Distracted driving contributes to more than 3,000 deaths and 400,000 injuries each year in the United States. Thirteen percent of these deaths have been linked to phone use while driving; among drivers aged 15 to 24 yr, that figure is 20 percent (NHTSA 2020).

Those quantifying the risk of distracted driving have found that taking one's eyes off the road for 5 s—the average time it takes to respond to a text—increases crash risk by a factor of nine (Simons-Morton et al. 2014). Consistent with this research, Progressive® Insurance has found that hand-held phone use while driving is a predictor of crash claims. Their usage-based insurance (UBI) program Snapshot® now considers hand-held use in pricing insurance policies.

Behavioral interventions, strategies commonly used in medicine and public health to encourage positive behaviors in individuals or groups of people, demonstrated prior successes that may be applied to reduce distracted driving. Across two nationwide, randomized controlled trials involving Progressive Snapshot customers, researchers for this study tested interventions designed to reduce hand-held phone use while driving. The interventions drew from multiple disciplines within behavioral science, including behavioral economics, social psychology, and neuroscience. At the time of the first trial, phone use was measured by the Snapshot Mobile app, but it was not a factor in insurance ratings. When the second trial was conducted, hand-held phone use was a factor—providing customers a built-in incentive to put down their phones while driving.

In trial 1 of this study, participants were randomly assigned to one of six trial groups, or “arms,” for a 50-d intervention period: control; weekly social comparison feedback; delayed, lump-sum financial incentive; weekly social comparison feedback plus delayed, lump-sum financial incentive; weekly social comparison feedback plus weekly loss-framed financial incentives; and weekly social comparison feedback plus doubled weekly loss-framed financial incentives, respectively. After adjustment for multiple comparisons, arms 4, 5, and 6 were significantly different from control on the primary outcome of the proportion of time participants engaged in hand-held use while driving. Arm 5 had the biggest relative reduction in hand-held use, about 23 percent.

Trial 2's interventions focused on shifting participants from a risky habit (hand-held phone use while driving) to a less risky one (hands-free use) over the course of a 70-d intervention period. There were five arms, with each successive arm adding an intervention on top of what the other arms delivered: education-only

control; free phone mount; goal commitment plus habit tips; gamification plus social competition; and financial incentives tied to gamification and competition performance. After adjustment for multiple comparisons, arms 4 and 5 were significantly different from control on the primary outcome during the intervention and postintervention periods. Arm 5 had the greatest relative reduction in hand-held use of about 25 percent.

Taken together, these trials demonstrate the importance of social comparison feedback and modest financial incentives for motivating drivers to cut back on hand-held phone use, a major source of distraction. To help make this change in behavior endure, researchers in this study recommend providing drivers with an acceptable alternative to hand-held use, giving them tips and reminders to help them form new and safer habits, and supporting them for at least 10 w as they practice disengaging from hand-held use while driving. Applying this model to a larger population could reduce vehicular accidents and the economic and human toll they cause.

INTRODUCTION

Risks of Distracted Driving

Globally, 1.35 million people die each year in motor vehicle crashes, costing many countries more than 3 percent of their gross domestic product (WHO 2021). Driving while distracted is a major contributor. In the United States in 2019, distracted driving caused 986,000 motor vehicle crashes, and these accidents resulted in 3,142 deaths and 424,000 injuries (NHTSA 2021). That year saw a larger percentage of crashes involving distracted driving—15 percent—than did the prior 4 yr.

Distracted driving is a common phenomenon that includes talking to a passenger, adjusting the radio, or fishing for a map in the glove box. The ubiquity of smartphones, however, is a recent development that often redirects peoples' attention away from the road while they are driving. Among distracted driving deaths, 13 percent have been linked to phone use; among drivers aged 15 to 24 yr, that figure is 20 percent (NHTSA 2020).

Hand-held phone use is especially distracting as it can pull both attention and vision away from the road. Researchers attempting to quantify the risk of distracted driving have found that taking one's eyes off the road for 5 s—the average time it takes to respond to a text—increases crash risk by a factor of nine (Gershon et al. 2019; Klauer et al. 2014; Simons-Morton et al. 2014). Data from the automobile insurance company Progressive show that drivers who engage in more hand-held phone use while driving have more crash claims (Progressive Insurance 2019).

UBI

A rise in distracted driving and crash claims over the prior decade contributed to a 30 percent increase in auto insurance premiums (Zebra 2020). Of course, not everyone drives while distracted or presents a heightened crash risk—a fact that has spurred the rapid adoption of UBI. In a UBI program, a smartphone app or plug-in telematics device monitors how people drive to assess their risk and to price their insurance policy accordingly (Arumugam and Bhargavi 2019). Companies that offer UBI have been able to decrease their insurance losses by better predicting future claims (Tselentis, Yannis, and Vlahogianni 2017).

The newest generation of smartphone telematics apps has the ability to capture phone use while driving by using classification algorithms to distinguish between driver and passenger use (Stock 2019). Some insurers now incorporate phone use as part of UBI scores, meaning that drivers' insurance rates are partly determined by how much they engage in hand-held use while driving (Progressive Insurance 2021).

Most of the top 10 U.S. auto insurers now offer some form of UBI. Market analysts predict that by 2023 there will be 142 million automotive UBI subscribers globally, including 60 million in the United States alone (Sims 2021). Increasingly, the amount and kind of phone use drivers engage in will be monitored, and customers will be disincentivized from the riskiest kinds of phone use. It remains to be seen whether the prospect of future discounts on auto insurance rates will change this behavior that many drivers engage in despite knowing it is risky (AT&T 2012).

Ingredients for Behavior Change

Typically, people will engage in a behavior if they are sufficiently motivated, their abilities meet or exceed what is required, and they are prompted to do so (Fogg 2009).

Motivation can stem from knowledge that the behavior is good for themselves or others, a desire for social approval, the fear of punishment for failing to engage in the behavior, or financial incentives. A person's motivation can be more intrinsic or more extrinsic. Paying people (extrinsic) may motivate them in the short term, but it offers no guarantee they will continue to perform the behavior once the money stops (Deci and Ryan 2008). When a person's motivation comes from within (intrinsic), the promise of rewards or the threat of punishment is often unnecessary: the person is more likely to engage in the behavior of their own volition.

When individuals' motivation is sufficiently high for particular tasks, often they will succeed if their abilities

match or exceed task requirements. A corollary is that the more difficult a task, the more motivation is needed for an individual to perform it. All things being equal, those seeking to promote behavioral change should, therefore, make the target behavior as easy to perform as possible. These requirements may include providing tools or reengineering the person's environment to pave the way for the desired behavior (Duckworth, Gendler, and Gross 2016). It may also mean breaking down the behavior into smaller, more manageable steps (Fogg 2009).

Motivation and ability to engage in a behavior may be high, but people may not remember to do so—hence the role of prompts. Like a motivation, a prompt can be external or internal. External prompts include physical (e.g., sticky notes) or digital (e.g., cellphone alerts) reminders to perform the behavior. "If I am in situation X, then I will do Y" is an internal prompt that a person may create ahead of time as a reminder to act when a situation arises (Gollwitzer 1999). Just as an internal motivation is important to sustain a behavior when external motivators cease, so too is an internal prompt helpful in encouraging action in the absence of external prompts (Stawarz, Cox, and Blandford 2015).

Consistent performance of new behaviors transforms them into habits over time. When a behavior has reached habit status, motivation or willpower often becomes much less important for successful performance (Gillebaart and Adriaanse 2017). How long it takes to form a new habit depends on the behavior and the individual. For a simple behavior, such as drinking a glass of water after breakfast, researchers have found that with daily practice, a habit can be formed in an average of 66 d, but with considerable individual variation ranging from 18 to 254 d (Lally et al. 2010). Other research has arrived at similar estimates. For instance, forming a habit of going to the gym takes a minimum of 6 w of consistent visits (Kaushal and Rhodes 2015).

In some cases, a person may desire to break an existing bad habit. It has been proposed that an effective way to do so is to replace the bad habit with a new one that can be performed in similar circumstances and provide many of the same rewards (Duhigg 2012). The effectiveness of this approach can be seen in certain harm-reduction strategies. For instance, one study found that encouraging tobacco smokers to switch from smoking cigarettes to vaping e-cigarettes (a similar but less risky behavior) was more effective than supplying them with a nicotine patch, and it was six times more effective than their simply trying to quit without any treatment (Hajek et al. 2019).

The Present Research

The primary aim of this research was to apply insights from behavioral science to reduce distracted driving. It is too soon to tell if the growing popularity of UBI programs that disincentivize hand-held phone use will reverse the trend toward higher rates of distracted driving, but there are reasons for doubt. Phone use is a relatively automatic, habitual behavior for many, making it difficult to undo (Bayer and Campbell 2012). The social and instrumental rewards people get from using their phone are immediate and certain (Hill, Sullman, and Stephens 2019), whereas insurance discounts from refraining from phone use are delayed and uncertain. Finally, although banning hand-held phone use while driving may reduce driver fatalities (Zhu et al. 2021), people continue to engage in this behavior at high rates (NHTSA 2019)—again, perhaps because punishment is delayed and uncertain.

Breaking the cycle of hand-held phone use while driving will likely require multifaceted, behaviorally informed solutions. These solutions may include optimizing the timing and framing of financial incentives for maximum effect, increasing intrinsic motivation to change, providing tools to make change easier, delivering reminders about not engaging in hand-held use while driving, offering alternatives to hand-held use, and helping drivers form new and better habits.

Researchers in this study conducted two trials in partnership with Progressive Insurance to test some of these potential solutions. Progressive's Snapshot is one of the largest UBI programs in the world, and the researchers were able to recruit enough participants for each trial to test several interventions for reducing hand-held phone use. Samples were diverse with respect to age, race/ethnicity, and geography, giving the team greater confidence in the generalizability of the findings. Finally, the Snapshot Mobile app could distinguish between driver and passenger trips and detect different kinds of hand-held and hands-free phone use while driving, enabling researchers to measure meaningful outcomes.

In the first trial, the team investigated how driver feedback and different incentive amounts, structures, and framings impact hand-held phone use while driving. In the second, it investigated interventions designed to promote lasting change in people's patterns of phone use while driving.

TRIAL 1: FEEDBACK AND FRAMED INCENTIVES

Background

The transition to pricing auto insurance based on observed driving behavior presents an opportunity to

encourage safer driving and reduce crashes on a large scale. The status quo for UBI programs is to monitor and provide feedback on risky driving behaviors (e.g., hard braking, late-night driving, speeding, and now phone use), then provide a personalized rate on the next 6-mo insurance policy or provide cash-back rewards every 6 mo. By applying insights from behavioral science, UBI could be redesigned to be more effective at reducing risky behaviors such as distracted driving owing to phone use (Delgado, Wanner, and McDonald 2016; Papadimitriou et al. 2019).

The researchers collaborated with Progressive Insurance and their telematics software vendor TrueMotion, Inc. (now Cambridge Mobile Telematics) to conduct a randomized, controlled trial that evaluated the efficacy of five behavioral interventions for reducing hand-held phone use while driving. Participants were recruited from Progressive Snapshot customers who used the Snapshot Mobile app. At the time of the trial, the app recorded phone use while driving for research purposes, but drivers were not yet rated on their phone use. Nor were they given a frame of reference in the app to help them interpret how risky their phone use was. The absence of insurance discounts and detailed feedback allowed researchers to test how different incentive structures and feedback on phone use might impact drivers' behavior.

Researchers hypothesized that providing customers with feedback on how their hand-held phone use compared with others would motivate those with comparatively high levels of use to cut back. In addition, researchers hypothesized that providing weekly incentives would be more effective than providing one lump sum at the end of the study, and how the incentives were framed to participants would matter as much as the sums involved.

Methods

The trial protocol was approved by the Institutional Review Board of the University of Pennsylvania. Progressive Insurance customers were eligible if they had been enrolled in the Snapshot Mobile program for between 30 and 70 d. Beginning on May 9, 2019, eligible customers on single-vehicle and single-driver policies received one or two emails from Progressive inviting them to participate. The emails included a link to a web page with information about the study. Customers were informed that the purpose of the study was to test if the Snapshot Mobile app could help reduce distracted driving. They were told they were guaranteed a total of \$20 for completing two study surveys and that they would have a chance to get an additional \$50 to \$100 depending on the group to which they were randomly assigned. It was emphasized that money earned through the study was distinct from any Snapshot discount

they might get. Finally, they were told that they might receive push notifications in their Snapshot Mobile app while participating.

Customers who agreed to participate provided their email addresses and completed an intake survey. This survey asked for their following:

- Type of smartphone.
- Frequency of using a phone mount, Bluetooth®, and dashboard touchscreen.
- Frequency of letting passengers use the participant's phone and frequency of being a passenger themselves.
- Use of do-not-disturb-while-driving features.
- Level of education and household income.
- Race/ethnicity.
- Perceptions of how their driving compared with that of others.
- Number of years with a driver's license.
- Number of traffic tickets and accidents in the prior 5 yr.
- Various kinds of phone use while driving and the automaticity of this behavior.
- Willingness to give up phone use while driving.

The survey ended with a five-item delay discounting task (Koffarnus and Bickel 2014). Each item asked, hypothetically, whether the participant would prefer \$500 now or \$1,000 at some future time (e.g., 3 w). If they chose the future option, the next item would ask them to choose between \$500 now and \$1,000 at a more distant future time (e.g., 2 yr); if they chose the immediate option, the next item would pose a choice between \$500 now and \$1,000 at a time in the nearer future (e.g., 1 d). This task allows researchers to efficiently determine an individual's discount rate for future rewards—that is, the degree to which the individual favors rewards in the present.

Participants were randomly assigned to one of six arms for a 50-d intervention period, which began May 13, 2019.

Arm 1: Control

Arm 1 served as the control group. Participants' phone use was measured by the Snapshot Mobile app, but they were given no feedback about how their hand-held phone use compared to that of others, and they were given no incentive to reduce their use. All participants were reminded that phone use did not factor into Progressive's UBI discounts.

Arm 2: Feedback

In arm 2, participants received weekly feedback about how their hand-held phone use compared to that of others. Given that more than 80 percent of people optimistically believe they are better-than-average drivers (Svenson 1981) and that phone use while driving is often an unconscious habit (Bayer and Campbell 2012), researchers theorized this objective feedback would raise participants' awareness of their own distracted driving behavior and motivate them to reduce it.

If weekly hand-held use was greater than the historical median for Snapshot customers with similar demographics (age, sex, marital status, and geographic residence), participants received a push notification in the Snapshot Mobile app telling them that most customers used their phone less than they did (figure 1). If weekly use was less than or equal to the median but more than the 10th percentile usage (better than average), participants were told that, if they used their phone less, they would be one of Progressive's best drivers. If their use was less than or equal to the 10th percentile usage (top performer), they were told they were one of the best drivers and encouraged to keep up the good work.

Figure 1. From top to bottom, the messages arm 2 participants received if they were in the greater-than 50th percentile (worse than average), between the 50th and 11th percentile (better than average), and the 10th percentile or lower (top performer) in hand-held phone use while driving.

★ out of 3 stars. Not bad, but more than half of our drivers used their 📱 less than you this week. Less swiping, typing, and holding your phone and you can move up the ranks!

★★ out of 3 stars. Almost there! You're better than at least half of our drivers at staying off your 📱. A little less swiping, typing, and holding the phone and you'll be one of our best drivers! 🏆.

★★★ out of 3 stars! You're one of our best drivers this week ranking in the top 10% of our drivers! Wow! Stay off your 📱 while you drive to keep up the streak! 🏆

Source: FHWA.

Arm 3: Standard Incentive

Arm 3 was designed to be like a typical UBI program with an incentive (maximum \$50) awarded at the end of the intervention period and no weekly social comparison feedback. Participants were told that if they finished as a top performer, they would receive the full \$50; if better than average, they would get \$25; and, if worse than average, they would get no money.

Arm 4: Standard Incentive Plus Feedback

Arm 4 participants received both the standard incentive (maximum \$50) and the weekly social comparison feedback. They received weekly notifications that they needed to keep their phone use low to earn money at the end of the intervention period (figure 2).

Arm 5: Reframed Incentive Plus Feedback

Arm 5 was designed with insights from the field of behavioral economics. First, researchers considered present bias, a preference for immediate rewards that can lead to phone use while driving despite the potential costs (Hayashi et al. 2016). Instead of offering a lump sum at the end of the intervention period for avoiding phone use, researchers offered smaller, weekly incentives totaling the same amount (maximum \$50) with the hope that these more immediate rewards could more effectively compete with the rewarding nature of phone use. Participants were eligible to receive the full weekly incentive (\$7.15) if they finished as top performers for the week, and they received half (\$3.58) if they finished better than average.

Figure 2. From top to bottom, messages the arm 4 participants received if they were in the greater-than 50th percentile (worse than average), between the 50th and 11th percentile (better than average), and the 10th percentile or lower (top performer) in hand-held phone use while driving.

Remember, you need to use your phone less than half of our other drivers to earn 💰 at the end of the study! Safety pays!

Remember, you need to be in the top 10% to earn the full \$50 at the end of the study! Safety pays! 💰

Great job at putting the 📱 down! More weeks like this give you a higher chance of earning 💰 at the end of the study

Source: FHWA.

Second, researchers capitalized on loss aversion—the avoidance of losses over equivalent gains—by telling participants to expect weekly payments, but those would be withheld if their phone use was too high (Kahneman et al. 1991). Third, researchers leveraged regret aversion—the preference for minimizing regret in decision making—by presenting a running tab of money lost each week for failing to be top performers (Zeelenberg et al. 1996). Fourth, researchers made use of the fresh start effect—people are more likely to act toward a goal after a particular date or special event—by telling participants who failed to finish as top performers that they would receive fresh starts to earn money the next week (Dai, Milkman, and Riis 2014). Arm 5 participants also received the weekly social comparison feedback described previously (figure 3).

Figure 3. From top to bottom, messages that arm 5 participants received if they were in the greater-than 50th percentile (worse than average), between the 50th and 11th percentile (better than average), and the 10th percentile or lower (top performer) in hand-held phone use while driving.

You missed out on your weekly payment this week and a total of \$[MONEYLOST] so far this study. No worries, fresh start! Use your phone less to get ★★ and 💰 next week! Safety pays!

Nice, you earned half your weekly payment, but you have missed out on \$[MONEYLOST] so far this study. Use your phone less to get ★★★ and the full weekly payment 💰 next week! Safety pays!

Congrats!!! You earned the full weekly payment for staying off your 📱 while driving! Keep it up and don't miss out on any 💰! Safety pays!

Source: FHWA.

Arm 6: Doubled Reframed Incentive Plus Feedback

Arm 6 was designed to test the dose-response effects of larger incentives. The intervention was identical to that of arm 5, except the total incentive was doubled (maximum \$100, with weekly incentives of \$14.29 for top performers and \$7.15 for better than average).

In table 1, arms 2, 4, 5, and 6 received weekly social comparison feedback. Arms 3 and 4 received lump sum incentives at the end of the intervention period, and arms 5 and 6 received smaller, weekly incentives. The incentive amounts in arm 6 were double those for the other arms.

Table 1. Feedback and incentive structure for the six trial arms.

Arm	Weekly Social Comparison Feedback	Incentive Design	Incentive Amount (Maximum) (Dollars)
1	No	—	—
2	Yes	—	—
3	No	Standard UBI (end of intervention period)	1/day (50)
4	Yes	Standard UBI (end of intervention period)	1/day (50)
5	Yes	Weekly, loss framed	1/day (50)
6	Yes	Weekly, loss framed	2/day (100)

—Arm did not include incentives.

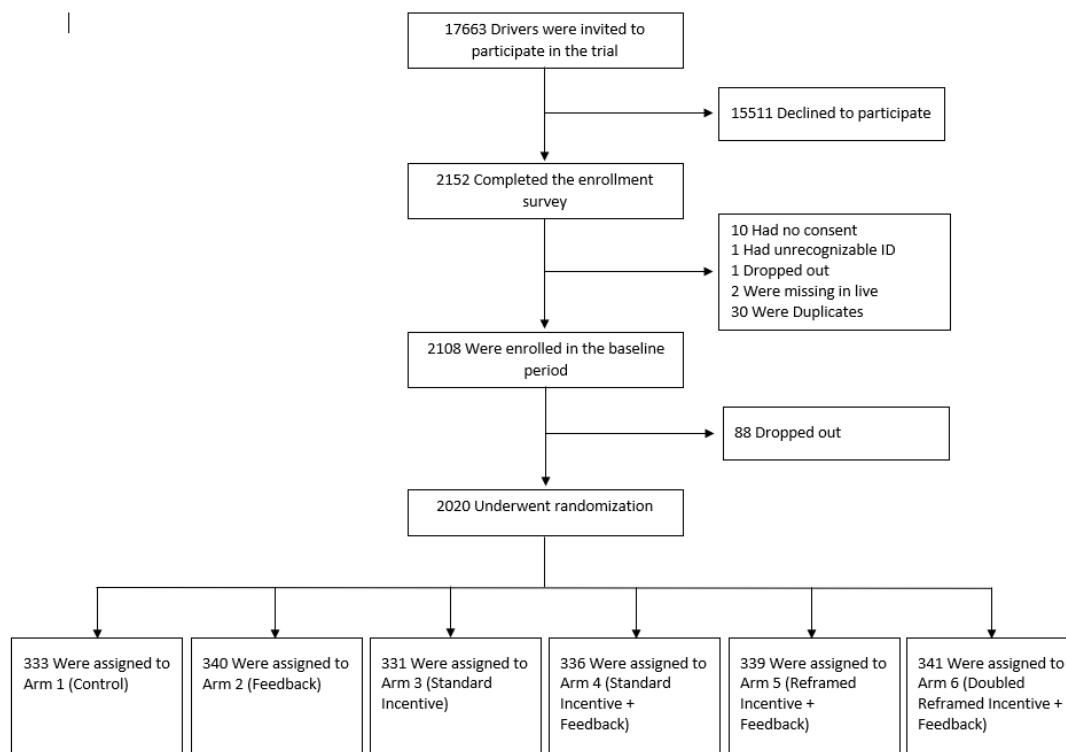
During the trial, researchers also tested a nudge designed to encourage situational self-control by removing the temptation to respond to text messages and app notifications (Duckworth et al. 2016). Participants with iPhones® in all arms, including the control group, received a total of three push notifications inviting them to set iPhone’s “Do Not Disturb While Driving” (DNDWD) to activate automatically. At the time of this trial, a comparable setting was not widely available on Android™ phones; participants with Android phones thus served as a control group for this intervention.

After the intervention period, participants’ phone uses and driving behaviors continued to be monitored for the remainder of their approximately 150-d Snapshot rating period, which allowed the researchers to test whether any behavioral changes persisted after incentives and feedback had ceased.

The primary outcome was the proportion of drive time participants engaged in hand-held phone use during the intervention period as measured by the Snapshot Mobile app. This difference included hand-held calls and non-call use (e.g., texting, swiping, typing, using navigation apps while the phone was in their hand). It did not include hands-free phone use (e.g., Bluetooth calls) and passive use (e.g., streaming navigation directions in a phone mount). All data collection and interventions were carried out by Progressive and TrueMotion. De-identified data were transmitted to the University of Pennsylvania for analysis.

Participants

A total of 17,633 customers were invited to participate in the trial. Of these, 2,020 consented, completed the intake survey, and underwent randomization (figure 4).

Figure 4. Trial 1 enrollment diagram.

Overall, participants had demographic characteristics similar to those who were eligible but did not participate. There were three statistically significant exceptions between participants and nonparticipants: mean age (33.3 yr versus 32.4 yr); female (67.9 percent versus 57.2 percent); and holders of college degrees (37.1 percent versus 29.5 percent).

A total of 2,020 individuals from 42 States participated in the trial. Ages ranged from 17 to 83 yr old; 69 percent were White, 24 percent Black, and 11 percent Hispanic.

Some 18 percent resided in urban ZIP codes, 60 percent in suburban, and 22 percent in rural. More participants used iPhones (66 percent) than Android phones (34 percent). Most drove cars that could connect to their phones for a hands-free option via Bluetooth or other means (82 percent), and a minority (35 percent) drove cars in which the phone functions could be manipulated via an in-vehicle dashboard. Table 2 shows these and other characteristics by trial arm.

Table 2. Trial 1 baseline phone usage, demographics, and other characteristics by arm.

	1. Control	2. Feedback	3. Standard Incentive	4. Standard Incentive Plus Feedback	5. Reframed Incentive Plus Feedback	6. Double Reframed Incentive Plus Feedback
<i>n</i>	333	340	331	336	339	341
Length of enrollment in baseline, median [IQR] (min/h)	50.0 [39.0, 60.0]	50.0 [40.0, 59.0]	49.0 [38.0, 59.0]	50.0 [39.8, 59.0]	51.0 [39.0, 60.0]	50.0 [41.0, 61.0]
Baseline period hand-held phone use, median [IQR] (min/h)	4.2 [1.4, 8.3]	3.4 [1.2, 8.1]	3.4 [1.2, 8.6]	3.9 [1.4, 8.2]	3.3 [1.1, 7.1]	3.5 [1.1, 7.5]
Proportion of baseline hand-held use due to calls, median [IQR]	0.093 [0.027, 0.244]	0.084 [0.017, 0.228]	0.086 [0.022, 0.234]	0.096 [0.032, 0.254]	0.097 [0.014, 0.237]	0.080 [0.015, 0.240]
Baseline hours of driving per week, median [IQR] (h/w)	7.1 [4.3, 10.6]	6.6 [3.9, 9.9]	7.1 [3.9, 10.7]	6.7 [4.0, 10.9]	6.2 [3.8, 9.9]	6.6 [4.0, 9.8]
Age, median [IQR] (yr old)	30.0 [25.0, 39.0]	30.0 [25.0, 37.0]	31.0 [25.0, 40.0]	30.0 [25.0, 38.0]	31.0 [25.0, 42.0]	30.0 [26.0, 38.0]
Sex—female, <i>n</i> (percent)	242 (72.7)	230 (67.6)	224 (67.7)	223 (66.4)	223 (65.8)	231 (67.7)
Marital status—married, <i>n</i> (percent)	43 (12.9)	41 (12.1)	48 (14.5)	50 (14.9)	51 (15.0)	42 (12.3)
Area of residence, <i>n</i> (percent)						
Rural	65 (19.5)	62 (18.2)	60 (18.1)	79 (23.5)	66 (19.5)	72 (21.1)
Suburban	208 (62.5)	202 (59.4)	209 (63.1)	206 (61.3)	215 (63.4)	203 (59.5)
Urban	60 (18.0)	76 (22.4)	62 (18.7)	51 (15.2)	58 (17.1)	66 (19.4)
Residence in State with universal hand-held ban—Yes, <i>n</i> (percent)	110 (33.0)	133 (39.1)	121 (36.6)	126 (37.5)	135 (39.8)	130 (38.1)

Table 2. (continued) Trial 1 baseline phone usage, demographics, and other characteristics by arm.

	1. Control	2. Feedback	3. Standard Incentive	4. Standard Incentive Plus Feedback	5. Reframed Incentive Plus Feedback	6. Double Reframed Incentive Plus Feedback
Race, n (percent)						
White	171 (66.8)	148 (59.9)	155 (62.0)	178 (68.7)	184 (67.9)	172 (68.0)
Black	62 (24.2)	60 (24.3)	69 (27.6)	57 (22.0)	65 (24.0)	55 (21.7)
Other	23 (9.0)	39 (15.8)	26 (10.4)	24 (9.3)	22 (8.1)	26 (10.3)
Income, n (percent)						
Below 50k	165 (64.2)	149 (60.1)	150 (59.8)	150 (58.1)	173 (63.6)	163 (64.2)
50k–100k	71 (27.6)	74 (29.8)	86 (34.3)	82 (31.8)	75 (27.6)	74 (29.1)
Over 100k	21 (8.2)	25 (10.1)	15 (6.0)	26 (10.1)	24 (8.8)	17 (6.7)
Level of education, n (percent)						
High school or less	70 (23.3)	77 (25.6)	59 (20.6)	78 (25.7)	66 (21.6)	80 (25.6)
Some college	96 (31.9)	114 (37.9)	100 (34.8)	98 (32.2)	108 (35.3)	110 (35.1)
College degree and above	135 (44.9)	110 (36.5)	128 (44.6)	128 (42.1)	132 (43.1)	123 (39.3)
Phone type, n (percent)						
Android	108 (32.4)	116 (34.1)	98 (29.6)	122 (36.3)	126 (37.2)	123 (36.1)
iOS®	225 (67.6)	224 (65.9)	233 (70.4)	214 (63.7)	213 (62.8)	218 (63.9)
Baseline use of automated DNDWD setting, n (percent)	97 (30.0)	107 (31.8)	99 (30.2)	88 (27.0)	97 (29.3)	104 (31.0)
Bluetooth/USB car connectivity, n (percent)	270 (83.3)	276 (81.7)	264 (80.7)	269 (82.5)	278 (84.0)	270 (79.6)
Dashboard touchscreen, n (percent)	110 (34.0)	112 (33.2)	113 (34.5)	125 (38.3)	116 (34.7)	119 (35.3)
Frequency of letting passenger use phone, n (percent)						
Never	107 (33.1)	98 (29.0)	125 (38.1)	112 (34.5)	117 (35.1)	114 (33.9)
1 to 2 d	106 (32.8)	117 (34.6)	113 (34.5)	99 (30.5)	108 (32.4)	114 (33.9)
3 d or more	110 (34.1)	123 (36.4)	90 (27.4)	114 (35.1)	108 (32.4)	108 (32.1)
Frequency of riding as a passenger, n (percent)						
Never	76 (23.5)	75 (22.2)	90 (27.4)	77 (23.6)	77 (23.1)	86 (25.7)
1 to 2 d	129 (39.9)	135 (39.9)	127 (38.7)	145 (44.5)	133 (39.9)	129 (38.5)
3 d or more	118 (36.5)	128 (37.9)	111 (33.8)	104 (31.9)	123 (36.9)	120 (35.8)

Table 2. (continued) Trial 1 baseline phone usage, demographics, and other characteristics by arm.

	1. Control	2. Feedback	3. Standard Incentive	4. Standard Incentive Plus Feedback	5. Reframed Incentive Plus Feedback	6. Double Reframed Incentive Plus Feedback
Number of traffic violations in prior 5 yr, n (percent)						
0	203 (64.6)	191 (59.0)	205 (63.7)	179 (57.7)	200 (62.5)	191 (58.1)
1	68 (21.7)	83 (25.6)	69 (21.4)	81 (26.1)	81 (25.3)	93 (28.3)
2	29 (9.2)	36 (11.1)	39 (12.1)	42 (13.5)	35 (10.9)	37 (11.2)
3 or more	14 (4.5)	14 (4.3)	9 (2.8)	8 (2.6)	4 (1.2)	8 (2.4)
Number of car crashes in prior 5 yr, n (percent)						
0	196 (62.4)	206 (63.6)	184 (57.1)	194 (62.4)	186 (57.8)	202 (61.4)
1	85 (27.1)	85 (26.2)	99 (30.7)	84 (27.0)	99 (30.7)	88 (26.7)
2	26 (8.3)	30 (9.3)	35 (10.9)	31 (10.0)	30 (9.3)	33 (10.0)
3 or more	7 (2.2)	3 (0.9)	4 (1.2)	2 (0.6)	7 (2.2)	6 (1.8)

n = number.

IRQ = interquartile range.

Results

Before the intervention, participants had been enrolled in Snapshot for a mean of 50 d, with a mean of 55 h of recorded driving. During this baseline period, participants engaged in hand-held phone use for a mean of 8.9 percent (320 s/h) of their driving time. The participants in the highest quartile of hand-held use accounted for 63 percent of all such use, with mean levels seven times greater than that in the lowest quartile.

Analyses were conducted with the intention-to-treat approach such that all participants who underwent randomization were included. The Snapshot Mobile app has an algorithm that classifies each automobile trip as either a driver trip or a passenger trip for the purposes of insurance ratings. Customers have up to 5 d after the trip to correct incorrectly classified trips in the Snapshot Mobile app (e.g., change a driver trip to a passenger trip). Only trips that were classified as a driver trip and not reclassified were counted in the primary outcome.

For the primary analysis, researchers used fractional regression with a logit link to compare proportions of drive time engaged in hand-held phone use among randomization arms during the 50-d intervention period. The model included the following prespecified covariates:

- Length of enrollment in the Snapshot program during the baseline period.
- Seconds of hand-held use per hour of driving during the baseline period.
- Proportion of baseline hand-held phone use owing to calls.
- Hours per week of baseline driving.
- Age.
- Sex.
- Marital status.
- Residential area (urban, suburban, rural).
- Race.
- Income.
- Education.
- Kind of phone.
- Whether they had DNDWD turned on at baseline.
- Bluetooth connectivity.
- Dashboard touchscreen.
- Frequency of passenger phone use.
- Frequency of riding as passenger.
- Traffic tickets in prior 5 yr.
- Car accidents in prior 5 yr.

This analysis was repeated for the postintervention period. Figure 5 shows the difference in hand-held use between each treatment arm and control after adjusting for covariates.

Each of the five treatment arms was compared to the control group. Researchers determined a priori five other between-group contrasts, yielding 10 total contrasts. They used the Holm method to handle multiple comparisons by sequentially testing the significance of each contrast against progressively less restrictive

alpha levels, maintaining a family-wise type I error rate of 0.05 (table 3). First, the 10 contrasts were ranked (lowest to highest) based on the raw p-value from the logistic regression. For a contrast to be significant using the Holm threshold, the raw p-value must be below the threshold for each row calculated as $(0.05/[n \text{ remaining contrasts}])$. For clarity of presentation, researchers report adjusted p-values derived by multiplying the raw p-value by the number of remaining contrasts, which can be compared directly to an alpha threshold of 0.05.

Figure 5. Plot of differences in adjusted mean hand-held use between each of the five trial 1 intervention arms and control, for both the intervention and postintervention periods, with 95 percent confidence intervals.

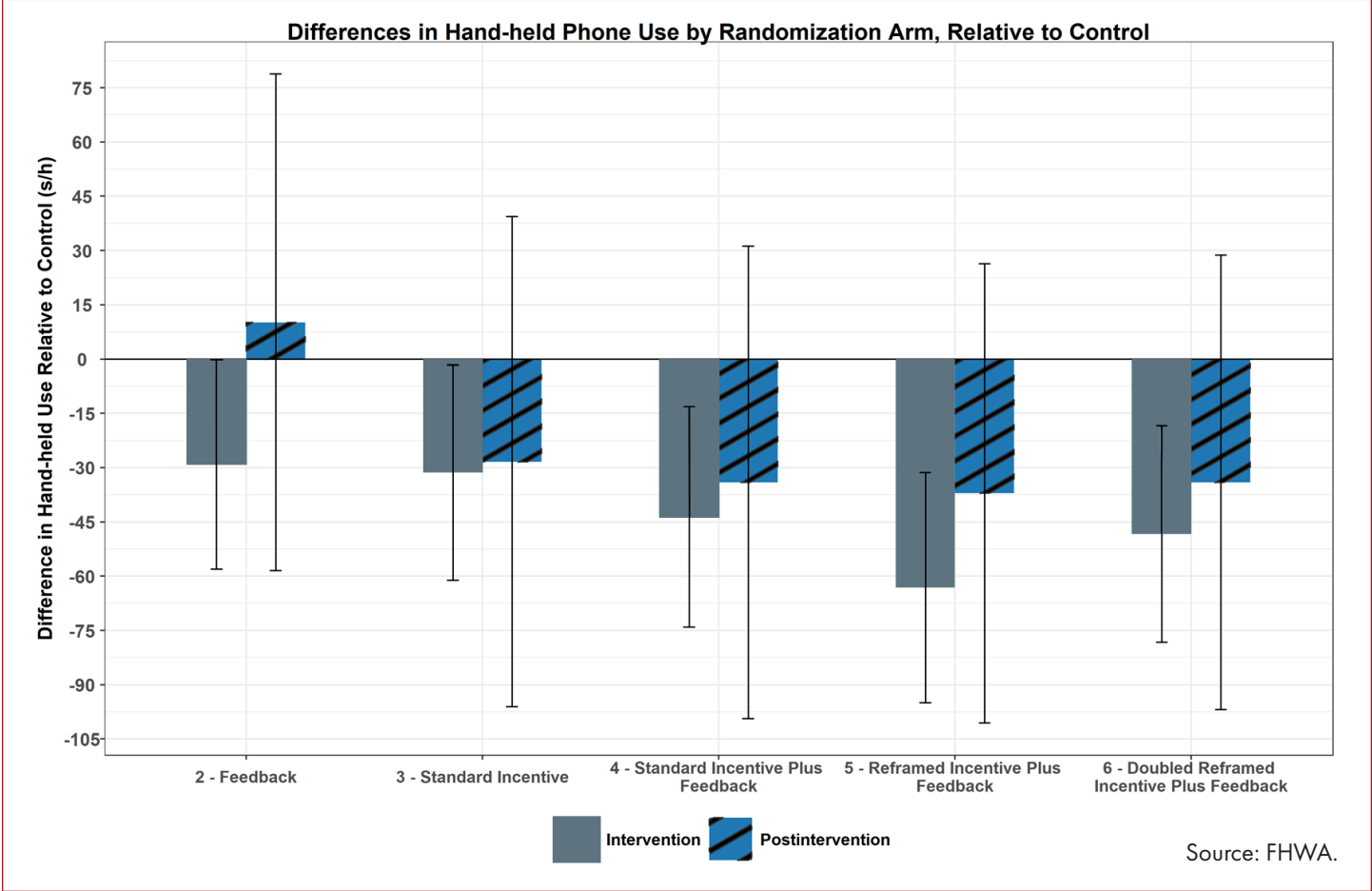


Table 3. Holm adjustment of p-values for trial 1 intervention period planned comparisons.

	Contrast	Raw p-Value	Rank	Remaining contrasts	Holm threshold	Adjusted p-Value
Arm 5 versus Arm 1	4	0.00000051	1	10	0.0050	0.000005148
Arm 6 versus Arm 1	5	0.000135	2	9	0.0056	0.001215
Arm 4 versus Arm 1	3	0.002	3	8	0.0063	0.016
Arm 3 versus Arm 1	2	0.019	4	7	0.0071	0.133
Arm 2 versus Arm 1	1	0.026	5	6	0.0083	0.156
Arm 5 versus Arm 4	9	0.1299	6	5	0.0100	0.6495

Table 3. (continued) Holm adjustment of p-values for trial 1 intervention period planned comparisons.						
Arm 6 versus Arm 5	10	0.213	7	4	0.0125	0.852
Arm 4 versus Arm 2	7	0.2842	8	3	0.0167	0.8526
Arm 4 versus Arm 3	8	0.3695	9	2	0.0250	0.739
Arm 3 versus Arm 2	6	0.8645	10	1	0.0500	0.8645

After correcting for the number of planned comparisons, neither arm 2 (Feedback) nor arm 3 (Standard Incentive) showed significant reductions in hand-held phone use relative to control. However, arm 4 (Standard Incentive Plus Feedback) reduced hand-held use by 44 s/h, a 15.7 percent reduction relative to control (adjusted $p < 0.05$).

The largest reduction occurred in arm 5 (Reframed Incentive Plus Feedback), which offered the same incentive amount as arm 4 but delivered it according to behavioral economics principles. These participants reduced their hand-held use by 63 s/h, a relative reduction of 22.7 percent (adjusted $p < 0.001$). Participants in arm 6 (Doubled Reframed Incentive Plus Feedback), which was identical to arm 5 except for its larger weekly incentives, reduced their hand-held use by 48 s/h, a relative reduction of 17.4 percent (adjusted $p < 0.005$). In the prespecified comparisons, none of the active intervention arms (i.e., 2–6) differed significantly from each other.

As a secondary analysis, researchers compared participants with iPhones to those with Android phones. The hypothesis was that iPhone participants would experience greater relative reductions in hand-held use due to receiving additional notifications encouraging them to activate DNDWD. Neither phone type nor any of the arms by phone type interaction terms researchers added to the model were significant (all $p > 0.09$). Thus, there was no evidence that iPhone users changed their behavior more than Android users, either overall or in response to the treatment arm interventions.

Last, to determine whether any changes in behavior were sustained after the interventions ceased, researchers compared hand-held use by treatment arm in the postintervention period using the same statistical model as the primary analysis. After Holm adjustment, there was no difference between any of the treatment arms and the control group (all adjusted $p > 0.91$).

TRIAL 2: BUILDING SUSTAINABLE HABITS

Background

Building on the success of trial 1 interventions, researchers sought to test novel interventions designed to help drivers create a lasting habit of putting down their phones when they drove. Researchers kept many of

the successful features from the first trial, such as social comparison feedback and weekly financial incentives. At the same time, researchers added new elements to strengthen intrinsic motivation (education about the risks of phone use while driving, option to commit to a phone use reduction goal), help participants plan for obstacles to reducing use, and reward both steady, incremental improvements and episodic, major changes in behavior.

From qualitative interviews with trial 1 participants, researchers knew that many who had successfully cut their hand-held use did so by starting to use phone mounts. For this reason, one of the interventions the researchers tested was the provision of a free phone mount—with or without additional reminders to use the mount. Researchers likewise took an explicitly harm-reduction approach to designing this trial. They told participants it is best not to use their phones at all while driving, but if they do to make sure it is hands-free use.

Given that trial 1 produced lasting change only for a subgroup of participants, researchers decided to lengthen the intervention period from 50 d to 70 d to give drivers more time to practice avoiding phone use (or switching from hand-held to hands-free use). Researchers also tested providing regular tips and prompts to encourage their new habits.

Exogenous changes provided new opportunities for trial design. After the end of trial 1, Progressive rolled out a new rating algorithm that factored hand-held phone use into insurance pricing. This action allowed researchers to recruit participants with an email advertising the potential discount they could earn by reducing their hand-held phone use. Also, researchers were able to bolster their interventions with reminders that a discount on their insurance was possible.

In addition, a joint decision was made to move study messaging from the Snapshot Mobile app to Penn’s Way to Health platform. This allowed for more flexibility and control over the messaging, a faster build, and greater personalization of the participants’ experiences. Instead of comparing participants to historical benchmarks for demographically similar Snapshot customers, as was done in trial 1, researchers were able to group them with other participants who were similar in terms of baseline hand-held phone use, then rank their performance relative to these peers each

week. Instead of providing the same static goals to all participants, researchers could provide tailored weekly goals based on individuals’ baseline hand-held use and how they performed during prior weeks.

Trial 2 interventions drew on social psychology, behavioral economics theory, and the science of self-control. Some interventions stoked intrinsic and extrinsic motivation to change and were designed to help participants overcome the immediate pull to use their phones while driving. Others were designed to make avoiding hand-held phone use easier. Still others were meant to prompt participants to engage in less risky behavior while driving.

Methods

Researchers conducted a randomized, controlled trial with Progressive Snapshot customers to evaluate the incremental and additive effectiveness of phone mount provision, commitment to reduce phone use and habit formation tips, goal gamification and social competition, and financial incentives on hand-held phone use while driving. The effectiveness of each treatment arm was evaluated by comparing its hand-held use to that of an education-only control arm, and to the arm with one less intervention. The five treatment arms are shown in table 4.

The study was conducted remotely with data collection via Snapshot Mobile. Snapshot customers who met the trial’s eligibility criteria were sent solicitation emails from Progressive indicating how much an average person like them could save on their auto insurance policy by reducing their hand-held phone use to less than 1 min/h, as well as how much they could earn just by completing the intake and exit surveys (\$20). All study payments were made in the form of Amazon™ gift codes.

Individuals were eligible if they:

- Were existing Snapshot Mobile users.
- Would be greater than 30 d and less than 70 d into their rating period at the time of the intervention launch.
- Were at least 18 yr old.
- Resided in a State in which phone use while driving was factored into their insurance rating.
- Had an email address.
- Were able to read and understand English.
- Took at least seven driving trips in one of the weeks of the baseline period.
- Averaged at least 2 min/h of baseline hand-held phone use.

This last criterion was necessary to ensure participants would have room to improve incrementally over the course of the 10-w intervention period.

Interested customers could click on a link that took them to an informed consent form in Qualtrics®. Those who gave their consent electronically and provided their contact information were enrolled, automatically randomized to a treatment arm, and taken to the intake survey. This survey asked about the make of their phone, driving history (e.g., length of licensure), self-reported phone use while driving, demographics, perceptions of level of phone use relative to others, use of settings to limit distracted driving (e.g., DNDWD), and willingness to reduce hand-held use. After completing these survey items, all participants received education about distracted driving. Those in arms 3, 4, and 5 also received a goal commitment exercise and habit tips.

Table 4. Each successive arm added a novel intervention(s) while retaining the interventions of the arms above it.					
	Education	Phone Mount	Commitment Plus Habit Tips	Gamification Plus Competition	Prize Money
Arm 1					
Arm 2					
Arm 3					
Arm 4					
Arm 5					

—Intervention not delivered in this arm.

After 1 w of survey data collection, necessary participant data were uploaded into the Way to Health platform, which handled the automated messaging during the intervention period. This messaging included additional habit reminders, goal gamification texts, and social competition emails, with and without language about potential prize money. Way to Health also administered the exit survey at the end of the intervention period. This survey repeated certain questions from the intake survey to see if participants had changed; included the five-item delay discounting task used in trial 1; asked participants what, if anything, motivated them to change and which interventions helped them to do so; and collected feedback about how the interventions could be improved and whether they would recommend the interventions to a colleague or friend.

The intervention period began on March 15, 2021, and lasted 10 w. Arms and interventions are described in the following sections.

Arm 1: Education

All participants (arms 1 through 5) were told that hand-held phone use makes driving less safe. They were given statistics about their crash risk from looking at their phones in hand for various lengths of time (e.g., “2 seconds: risk of a crash goes up 4x!”) and told that reading a text for 5 s while driving 55 mph is like driving the length of a football field with their eyes closed.

They also learned about laws banning phone use and how these have saved lives. This information was accompanied by a color-coded map of the United States showing the 48 States that, at the time, banned texting while driving outright and the one state with a partial ban.

Finally, it was recommended that they use hands-free options and place their phone in a phone mount to reduce hand-held phone use, which would keep themselves and others safer and help them get a bigger Snapshot discount.

Arm 2: Phone Mount

The Progressive distribution center mailed participants from arms 2 through 5 a free Beam Electronics® air vent phone mount, which is compatible with most iPhone and Android smartphone models.

Before shipping, Progressive affixed a reminder sticker to each unit. This sticker, designed in collaboration with Progressive’s marketing team, said “Driving? Park your phone here.” In pretesting, most people said they would be happy to have the sticker on their mount and its presence would make them want to put their phone in the mount.

Included with the phone mount was a note with basic instructions to clip the mount onto an air vent close to eye level. This note said to use the mount when participants needed to use their phones while driving and reminded them that hands-free phone use is safer and could mean a bigger discount on auto insurance.

Arm 3: Commitment Plus Habit Tips

After the education about distracted driving, participants in arms 3, 4, and 5 underwent commitment exercises and received habit formation tips.

Prior research has found that when individuals commit to a specific goal, this commitment increases the success of behavior change efforts (Locke and Latham 2002). To secure participants’ commitment to reducing their phone use while driving, researchers first invoked a social norm (Cialdini 2006): participants were informed that “90 percent of surveyed Snapshot customers are interested in reducing phone use while driving.” Researchers then asked them to advocate, in writing, for the position that it would be beneficial if everyone reduced their hand-held phone use while driving—an intervention that, when the advocacy feels freely chosen, can change the attitudes of the person doing the writing (Miller and Wozniak 2001). Participants were told that their response would be texted back to them during the study.

Next, researchers informed them about what their baseline hand-held usage was, in minutes per hour, and that the safest drivers in the Snapshot program—the ones with the biggest discounts—have hand-held use of less than 1 min/h. Researchers told them how much they would need to reduce their hourly hand-held use by each week (rounded to the nearest 10 s) to get down to 1 min/h over the course of the study. Finally, researchers asked them if they would commit to reducing their use by this amount each week until they got down to 1 min. These incremental weekly goals were designed to be specific, measurable, attainable, relevant, and time bound (Blanchard 1999).

To encourage compliance with this request, “Yes!” was the default survey response, but participants were free to change this to “No” (Li, Hawley, and Schnier 2013). Those who declined were still sent weekly goals later, but researchers acknowledged up front that they had not committed. For those who committed, these goals were framed as “pledged” goals.

Next, participants were given tips to help them change their behavior. First was an exercise meant to help them anticipate and plan for their three biggest obstacles to putting their phone down while driving (Gollwitzer 1999; Wang, Wang, and Gai 2021). They could choose from a menu of six common obstacles and plans to surmount them (e.g., “If I know I’ll need a global

positioning system, then I will enter where I'm going ahead of time."), or they could write their own. They were told that the plans they chose or supplied would be texted back to them later as reminders.

Participants were then told about the DNDWD feature available on iPhones or similar features on Android phones. If in the intake survey they had indicated they did not use this feature, they were asked to turn it on and set it to come on automatically when they were driving. If they indicated they already used it, but not automatically, they were asked to set it to come on automatically. If they indicated they already used it and set it to automatic, they were encouraged to keep doing so.

Participants were then encouraged to use phone mounts (their own or the ones researchers provided) whenever they needed to use their phones while driving. Last, they each chose what time they would like to receive their weekly habit formation tips by text message. They were asked to pick times when they usually would not be driving. If they did not provide times, the default was 2 p.m. in their time zones.

During the 10-w intervention period, they received habit tips three times per week on Mondays, Wednesdays, and Fridays for the first 2 w and once per week on Mondays for the remaining 8 w. These included reminders about the safety and financial benefits of reducing hand-held use, nudges about using DNDWD and a phone mount (including links to a website with instructions for activating DNDWD), and their earlier responses about why it would be beneficial for everyone to reduce use and their plans for surmounting obstacles (figure 6).

Another habit tip provided a mindfulness technique to reduce phone use (e.g., "Tip: The urge to check your phone is normal. We can't change the urge, but we can choose how we respond. When driving, notice

the urge and tell yourself, 'I won't check now.' 🧘") (Bowen and Marlatt 2009). Others encouraged the creation of internal prompts and intrinsic rewards so that participants were not wholly dependent on study prompts and rewards (e.g., "When you get in your car, what will remind you not to use your phone? How can you make sure any phone use is hands-free? 😊" and "Good habits stick when they're rewarded... When you don't touch your phone while driving, how can you give yourself a pat on the back? 🎉").

Arm 4: Gamification Plus Competition

While Arm 3 participants could commit to a weekly hand-held use reduction goal, they were not reminded of these goals during the intervention period, nor were they given feedback on whether they met each week's goal. Participants in arms 4 and 5 were provided this information via text messages. In addition, their weekly goals were "gamified"—game mechanics added to a nongaming environment—with the possibility to earn or lose points and to level up or down. Prior research has established the effectiveness of gamification on behavior change in a variety of domains (Bai, Hew, and Huang 2020; Johnson et al. 2016; Patel et al. 2017).

Participants began with 100 points at the silver level. They could gain 10 points, maintain their points, or lose 10 points each week of the intervention period, depending on whether they met their goal, fell short, or backslid (e.g., If their goal was to improve upon their prior goal by 30 s, but they missed it by 60 s, they would lose points). If they met their goals, the next week they were given incrementally more challenging goals; if they backslid, the next week they were given easier goals (but never easier than their initial goals). Participants who did not drive—and, therefore, had no hand-held phone use while driving—were considered to have met their goals.

Figure 6. Examples of habit formation tip text messages that were sent to arms 3, 4, and 5 during the intervention period.

Safety pays! The average driver like you can save up to \$85 on Progressive auto insurance 💰. How? By avoiding handheld phone use while driving.

Beep Beep 🚗
Remember when you said giving up phones meant: "Safer roads for all"? Think about that when you're driving!

We love car safety so we sent you a phone mount to help you keep your 👁️ on the road. Using the mount (even if you have a dashboard touchscreen) can save you 💰 on your auto insurance!

Hi! If you can't resist using your phone at least do it handsfree. 🙌
Try "Hey Siri" then: "Get me directions to ____",
"Play music by ____",
"Call ____"

Source: FHWA.

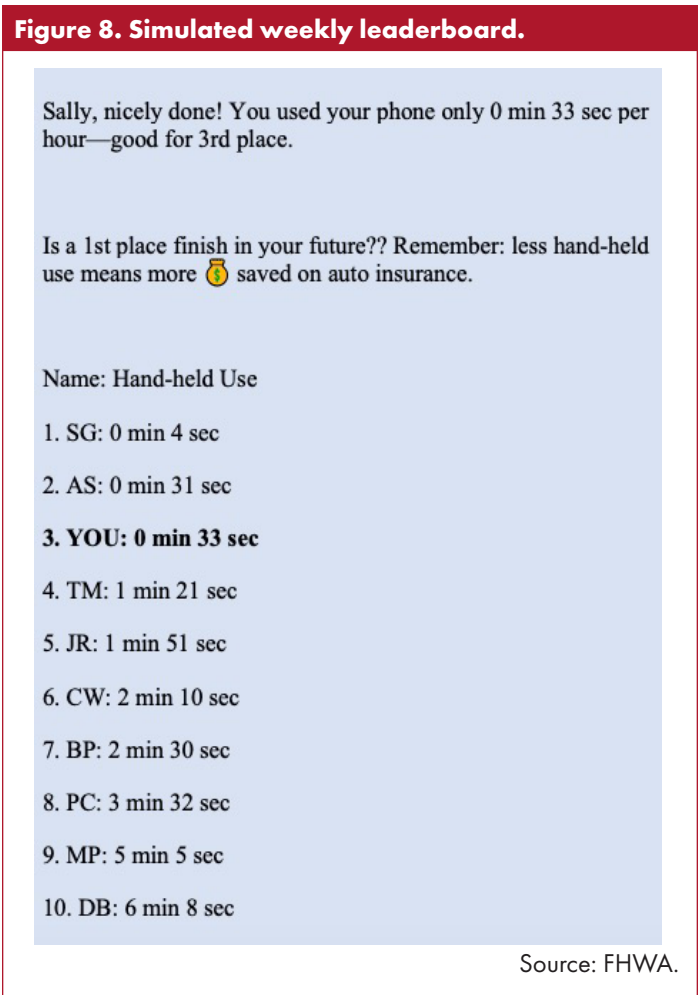
If participants earned enough points, they could advance to another level; if they lost too many points, they could fall back a level. Level 1 (no medal) was 0–40 points; level 2 (bronze) was 50–80 points; level 3 (silver) was 90–120 points; level 4 (gold) was 130–160 points; and level 5 (platinum) was 170–200 points.

Each Monday evening of the intervention period, the participants received a series of texts (figure 7) telling them the following: whether they met their goal, fell short, or backslid—and the point implications of their performance; their new level, if their level changed; that they could check their email for their weekly leaderboard ranking; their new goals for the upcoming week; and how many points they needed to reach the next level, if there were enough weeks remaining to reach it.

Those who met their goals were encouraged to continue their streaks with their upcoming goals (e.g., “Keep rolling 🚗”), while those who backslid were encouraged to think of the upcoming week as a fresh start (e.g., “Turn over a new leaf 🌱”) (Dai, Milkman, and Riis 2014). To keep these messages engaging over the course of the 10-w intervention period, the language and emojis used for participants who met their goals, fell short, or backslid, were different each week.

The social competition was meant to harness the power of social comparison and participants’ competitive drive in the service of reducing hand-held phone use while driving (Asch and Rosin 2016). For the competition, participants were grouped in cohorts of 10 or fewer drivers who had similar baseline usage.

Each Monday of the intervention period they received a leaderboard email showing who used their phone the least during the prior Monday–Sunday week (figure 8).



Their own usage in minutes and seconds per hour of driving appeared alongside the name “YOU”; everyone else’s usage appeared alongside anonymized initials. Participants were told at the outset that if someone drove less than 1 h they would not be included in that week’s leaderboard. Accompanying text reminded participants that they could get a discount on their auto insurance if they reduced their hand-held phone use while driving.

Both goal gamification and social competition were meant to motivate people, but in different ways. Goal gamification was a more solitary pursuit that rewarded consistency, persistence, and incremental growth. The downside was that once attaining the highest medal was impossible or a foregone conclusion, it was possible that motivation would flag. The leaderboard was more social and competitive, and it rewarded sporadic, large reductions in phone use. Anyone at any time could win—so it incentivized participants until the end. A downside was that participants’ rankings were partly outside their control: unless they reduced their hand-held use to nil, they could not guarantee being atop the leaderboard.

Arm 5: Prize Money

Arm 5 participants could earn financial incentives based on their performances in the goal gamification and social competition components of the intervention period.

Specifically, those finishing the 10-w period with platinum status were awarded an equal share of a \$2,000 prize. This was a variant of the more common “lottery” incentive, in which a randomly chosen participant wins the entire prize (Vlaey et al. 2019). This design ensured all participants who met the behavioral goal would receive a prize, but the amount to be received was unknown. Customers who left the Snapshot program during the intervention period were awarded a share of the prize if and only if their status was platinum at the time of their leaving. As part of their weekly goal gamification messaging, arm 5 participants who still had a chance to finish with platinum were reminded of the potential prize money (figure 9).

Figure 9. Example of an arm 5 text message reminding participants of the shared \$2,000 prize.

Just 20 points till Platinum! Finish with PLATINUM and get a share of the \$2,000 prize 🏆

Source: FHWA.

In addition, arm 5 participants could earn \$5 each week they finished atop their group’s leaderboard (maximum \$50). When multiple participants tied for first place, they each earned \$5. The weekly leaderboard included a “Total Winnings” column showing each person’s cumulative winnings, and the message accompanying the leaderboard reminded them the winner gets \$5.

Participants

On March 1, 2021, it was determined that 23,788 customers met the eligibility criteria (researchers later learned that 268, or 1.1 percent, were ineligible due to being under 18 yr old). Because of Snapshot attrition and other factors internal to Progressive, the solicitation email was sent to 20,795 customers (100 on March 1, the rest on March 3). Of these, 1,670 consented and were enrolled, and these participants were randomly assigned by Qualtrics to the five study arms. Progressive provided researchers with basic demographic data for all customers initially determined to be eligible, which allowed the team to compare those who were eligible

but did not enroll to those who did enroll (table 5). The enrollees had slightly less baseline hand-held use and were more likely to be female, urban, and college educated.

Our analyses were intent-to-treat. If a participant asked to unenroll ($n = 4$), their data were retained for analysis until the point of unenrollment. Likewise, researchers analyzed the data of customers who left Snapshot ($n = 236$) up until they left the program. Some participants ($n = 52$), especially those in arms 3, 4, and 5, texted “stop,” “bye,” or something similar, which stopped them from receiving future study texts; these individuals were still included in the analyses and sent the exit survey. Two participants were excluded from analyses because it was discovered that they had not been the intended, eligible targets of the solicitation email. After the intervention period ended, researchers learned that the solicitation email had been sent to customers without an 18 yr and older age restriction. Consequently, researchers needed to exclude an additional 15 participants who were between 15 and 17 yr old at time of enrollment. For the primary analyses, 1,653 participants were included (figure 10).

Among the 1,653 included participants, the mean age was 32.8 yr (range: 18–77 yr) and 66.5 percent were female; 62.4 percent were White, 20.5 percent Black, and 14.0 percent Hispanic; and 20.3 percent resided in urban ZIP codes, 59.5 percent in suburban, and 19.8 percent in rural. Table 6 shows these and other characteristics by trial arm.

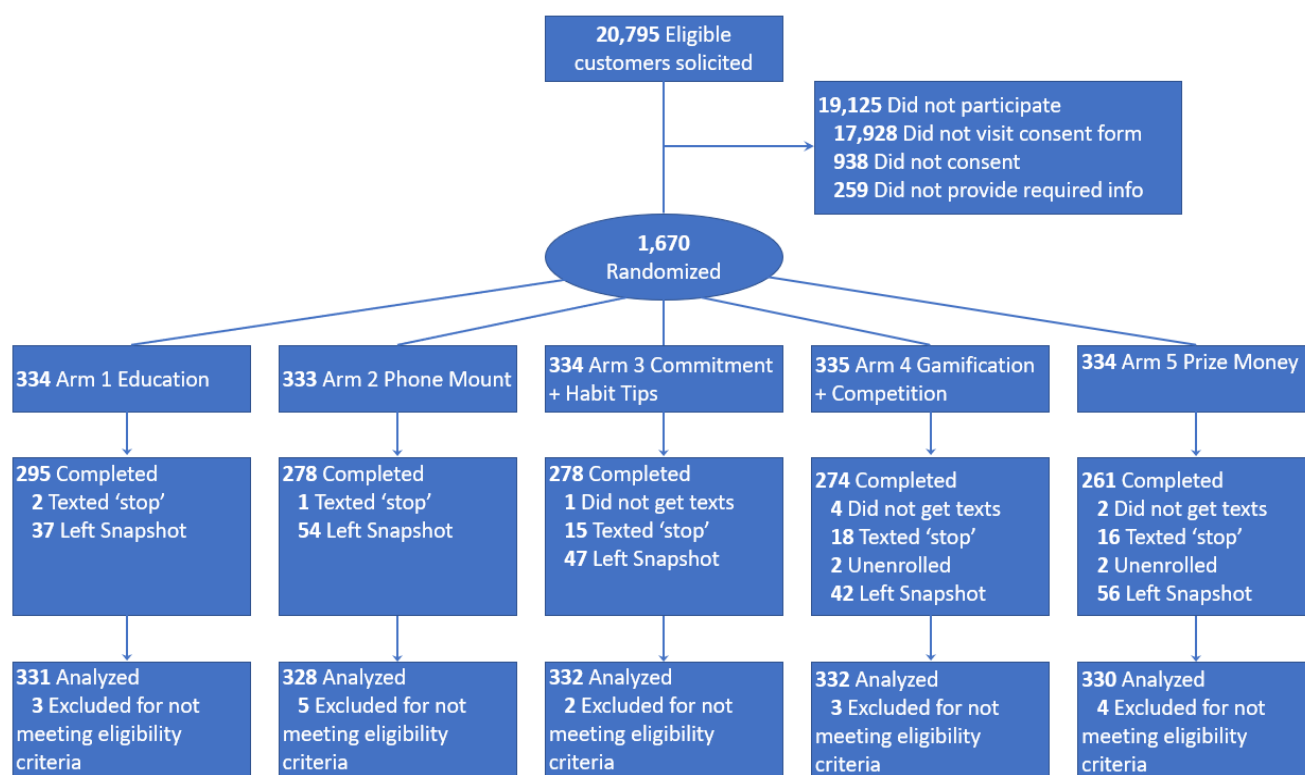
Table 5. Comparison of those who were initially deemed eligible for the trial but did not enroll to those who enrolled.

	Eligible, Not Enrolled	Enrolled
<i>n</i>	22,118	1,670
Age (yr old)	32.8	32.7
Maximum discount (dollars)	62.7	61.2
Baseline hand-held (s/h)*	444	419
Female (percent)	58.7	66.4
Single (percent)	73.4	74.5
Urban (percent)	17.6	20.1
Suburban (percent)	59.2	59.6
Rural (percent)	22.6	19.9
At least some college (percent)	58.5	69.3

n = number of participants.

*Note: For this comparison, baseline hand-held use was calculated by Progressive and included only trips during the month of February that were available as of March 1. The primary analyses used a lengthier baseline period dating back to January 4 for some participants, as well as a more complete and corrected set of trips.

Figure 10. Trial 2 enrollment diagram.



Note: The only exclusions were related to participant eligibility.

Source: FHWA.

Table 6. Trial 2 baseline phone usage, demographics, and other characteristics by arm.

	1. Education-Only Control	2. Phone Mount	3. Commitment Plus Habit Tips	4. Gamification Plus Competition	5. Prize Money
<i>n</i>	331	328	332	332	330
Baseline hand-held use, mean (SD) (min/h)	6.4 (5.2)	6.5 (4.6)	6.4 (5.0)	6.6 (5.0)	6.4 (4.9)
Estimated maximum potential insurance discount, mean (SD) (U.S. dollars)	61.93 (18.30)	60.44 (17.86)	60.44 (18.03)	60.66 (18.29)	61.80 (18.80)
Age, mean (SD)	32.3 (9.0)	33.5 (10.3)	32.8 (9.6)	32.8 (9.6)	32.7 (10.2)
Sex—female, <i>n</i> (percent)	208 (62.8)	218 (66.5)	216 (65.1)	228 (68.7)	229 (69.4)
Marital status—married (percent)	88 (26.6)	73 (22.3)	97 (29.2)	81 (24.4)	85 (25.8)
Location (percent)					
Rural	52 (15.7)	69 (21.0)	69 (20.8)	77 (23.2)	61 (18.5)
Suburban	205 (61.9)	199 (60.7)	186 (56.0)	189 (56.9)	204 (61.8)
Urban	73 (22.1)	60 (18.3)	75 (22.6)	64 (19.3)	63 (19.1)

Table 6. (continued) Trial 2 baseline phone usage, demographics, and other characteristics by arm.

	1. Education-Only Control	2. Phone Mount	3. Commitment Plus Habit Tips	4. Gamification Plus Competition	5. Prize Money
Race (percent)					
White	210 (63.4)	208 (63.4)	203 (61.1)	211 (63.6)	200 (60.6)
Black	60 (18.1)	67 (20.4)	75 (22.6)	66 (19.9)	71 (21.5)
Other	35 (10.6)	29 (8.8)	28 (8.5)	30 (9.1)	36 (10.9)
Level of education (percent)					
High school or less	55 (16.6)	59 (18.0)	51 (15.4)	49 (14.8)	40 (12.1)
Some college	89 (26.9)	103 (31.4)	100 (30.1)	100 (30.1)	110 (33.3)
College degree and above	170 (51.3)	149 (45.4)	162 (48.7)	164 (49.4)	159 (48.1)
Phone type (percent)					
Android	85 (25.7)	123 (37.5)	132 (39.8)	119 (35.8)	113 (34.2)
iOS	246 (74.3)	205 (62.5)	200 (60.2)	213 (64.2)	217 (65.8)
Baseline phone mount installed (percent)	116 (35.0)	92 (28.0)	111 (33.4)	109 (32.8)	102 (30.9)
Baseline use of automated DNDWD setting (percent)	57 (17.2)	57 (17.4)	46 (13.9)	40 (12.0)	54 (16.4)
Dashboard touchscreen (percent)	172 (52.0)	176 (53.7)	180 (54.2)	172 (51.8)	180 (54.5)
Frequency of letting passenger use phone (percent)					
Never	118 (35.6)	128 (39.0)	116 (34.9)	112 (33.7)	117 (35.5)
1 to 2 d	107 (32.3)	84 (25.6)	81 (24.4)	111 (33.4)	112 (33.9)
3 d or more	89 (26.9)	99 (30.2)	116 (34.9)	90 (27.1)	80 (24.2)
Frequency of riding as a passenger (percent)					
Never	73 (22.1)	62 (18.9)	68 (20.5)	62 (18.7)	64 (19.4)
1 to 2 d	137 (41.4)	118 (36.0)	117 (35.2)	123 (37.0)	114 (34.5)
3 d or more	104 (31.4)	131 (39.9)	128 (38.6)	128 (38.6)	131 (39.7)
Traffic violations in prior 5 yr, n (percent)					
0	189 (57.1)	194 (59.1)	184 (55.4)	172 (51.8)	183 (55.5)

Table 6. (continued) Trial 2 baseline phone usage, demographics, and other characteristics by arm.

	1. Education-Only Control	2. Phone Mount	3. Commitment Plus Habit Tips	4. Gamification Plus Competition	5. Prize Money
1	79 (23.9)	67 (20.4)	69 (20.8)	95 (28.6)	77 (23.3)
2	32 (9.7)	35 (10.7)	41 (12.3)	29 (8.7)	39 (11.8)
3 or more	13 (3.9)	15 (4.6)	19 (5.7)	16 (4.8)	10 (3.0)
Car crashes in prior 5 yr, n (percent)					
0	185 (55.9)	182 (55.5)	201 (60.5)	172 (51.8)	185 (56.1)
1	97 (29.3)	97 (29.6)	79 (23.8)	99 (29.8)	89 (27.0)
2	22 (6.6)	26 (7.9)	24 (7.2)	34 (10.2)	26 (7.9)
3 or more	10 (3.0)	6 (1.8)	9 (2.7)	8 (2.4)	9 (2.7)

n = number of participants.
SD = standard deviation.

Results

Manipulation Checks and Intervention Acceptability

As a manipulation check of the phone mount intervention, researchers compared the proportion of participants who reported having a phone mount installed in their car at intake versus exit survey. For arms 2 through 5, which received the free mount, 33.2 percent reported having a mount installed at intake and 88.6 percent at exit. By comparison, in arm 1, there was little change in reported phone mount installation: 36.9 percent at intake and 42.2 percent at exit.

We also checked self-reported use of a DNDWD phone setting, at intake and exit, for participants in arms 3, 4, and 5 who were encouraged to use this setting. At intake, 21.1 percent of respondents said they used DNDWD; at exit, more than double—43.8 percent—said they used this setting. By comparison, arms 1 and 2 participants reported 24.6 percent usage at intake and 31.5 percent at exit.

For the goal commitment intervention given to arms 3, 4, and 5, 98.7 percent of those who responded to the intake survey question said they would commit to weekly reductions in their hand-held phone use until they got it down to 1 min/h. Therefore, virtually every participant in arms 4 and 5 received weekly messages stating that their goals were “pledged.”

In the consent form, researchers informed participants that the \$2,000 prize would be split equally among all platinum finishers in arm 5. Researchers anticipated enrolling as many as 400 participants in this arm, but they could not predict how many participants

would attain platinum—and therefore how much prize money each platinum finisher would take home. As it happened, there were 330 eligible participants in arm 5, and 128 finished with platinum. Each of these platinum finishers received \$15.63.

Participants could opt out from receiving study short message service (SMS) messages at any time by texting “stop,” “bye,” or a similar expression. Participants in arms 3, 4, and 5 received the most text messages and were expected to opt out at a higher rate. Indeed, this is what happened (table 7).

Table 7. Number and percentage of participants in each study arm who opted out of receiving text messages.

Arm	Opt-Out Number (Percentage)
1. Education-Only Control	2 (0.6)
2. Phone Mount	1 (0.3)
3. Commitment Plus Habit Tips	15 (4.5)
4. Gamification Plus Competition	18 (5.4)
5. Prize Money	16 (4.8)

Despite receiving upward of seven text messages some weeks, the overall opt-out rate of participants in arms 4 and 5 was around 5 percent—suggesting widespread acceptance of the SMS-based interventions. A caveat is that researchers do not know what percentage of participants chose to *block* the study messages.

Primary Analysis

As was the case in trial 1, the primary outcome was seconds of active hand-held phone use per hour of driving. This is a composite variable that measured the proportion of total trip time in which the driver was engaged in hand-held phone call use or hand-held noncall use (e.g., texting, swiping, and typing) as measured by the Snapshot mobile application. Research has demonstrated the association between hand-held phone use (e.g., reaching for phone, typing, swiping, dialing) and increased crash risk (Klauer et al. 2014).

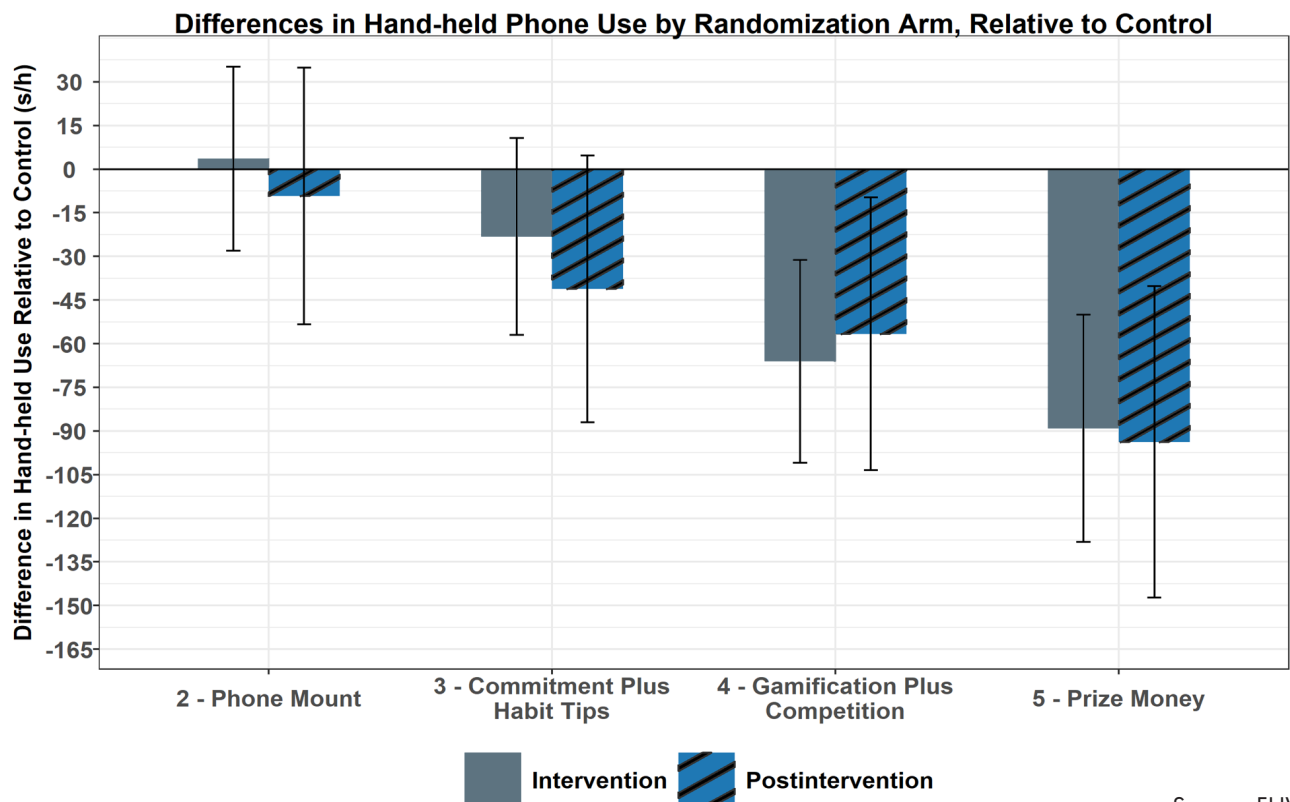
Researchers used fractional regression with a logit link function as the primary analytic model to assess effectiveness of the four intervention arms relative to control. Researchers prespecified three additional contrasts—arm 3 versus 2, arm 4 versus 3, arm 5 versus 4—for a total of seven. The model included several prespecified covariates:

- Baseline period hand-held phone use proportion.
- Proportion of baseline hand-held use due to calls versus noncalls.
- Mean hours of driving per week during baseline period.
- Age.

- Sex.
- Marital status.
- Urban.
- Suburban, or rural residence.
- Race/ethnicity.
- Income.
- Education level.
- Phone type (iPhone or Android).
- Baseline use of automated DNDWD setting.
- Dashboard touchscreen ownership.
- Frequency of letting passenger use phone.
- Frequency of riding as a passenger.
- Number of prior traffic violations in prior 5 yr.
- Number of car crashes in prior 5 yr.

Because arms 2 through 5 were compared principally to the arm 1 control, for both the intervention and postintervention periods, researchers calculated the difference between the mean for each arm and control (figure 11).

Figure 11. Plot of differences in adjusted mean hand-held use between each of the four trial 2 intervention arms and control, for both the intervention and postintervention periods, with 95 percent confidence intervals.



Source: FHWA.

Due to the multiple preplanned contrasts, researchers adjusted for multiple comparisons using the Holm method (table 8). First, the seven contrasts were ranked (lowest to highest) based on the raw *p*-value from the logistic regression. For a contrast to be significant using the Holm threshold, the raw *p*-value must be below the threshold for each row calculated as $(0.05/[n \text{ remaining contrasts}])$. For clarity of presentation, researchers reported adjusted *p*-values derived by multiplying the raw *p*-value by the number of remaining contrasts, which can be compared directly to an alpha threshold of 0.05.

After correcting for the number of planned comparisons, neither arm 2 (Phone Mount) nor arm 3 (Commitment Plus Habit Tips) showed significant reductions in hand-held phone use relative to control. However, arm 4 (Gamification Plus Competition) reduced hand-held use by 51 s/h, a 14.2 percent reduction relative to control (adjusted $p < 0.0001$). The incremental improvement of arm 4 over arm 3 was also significant (adjusted $p < 0.05$). The largest reduction occurred in arm 5 (Prize Money), which provided the same goal gamification and social competition elements as arm 4 but attached prize money to them. These participants reduced their hand-held use by 90 s/h, a relative reduction of 24.8 percent (adjusted $p < 0.00001$).

To test whether any behavior change persisted after study messages and incentives ceased, researchers repeated this analysis for the postintervention period

(table 9). Both arm 4 (adjusted $p < 0.05$) and arm 5 (adjusted $p < 0.0001$) continued to have less hand-held phone use than control during the postintervention period.

Additional analyses with total phone use (hand-held plus hands-free) as the outcome found no significant differences between any of the four treatment arms and control at intervention or postintervention (all $p > 0.22$). Arm 4 and 5 participants shifted from hand-held (riskier) to hands-free (less risky) phone use, but they did not increase their overall phone use.

CONCLUSIONS

Trial 1 was the first large-scale field experiment to investigate the separate and joint impact of incentives and behavioral science interventions (e.g., loss framing) designed to reduce hand-held phone use while driving. Advances in smartphone telematics made it possible to examine changes in actual risky driving behavior instead of relying on self-reports. Implementation of these interventions with one of the largest UBI auto insurance programs allowed for testing in a diverse, national sample. It paves the way for rapidly translating and scaling findings into practice.

The results show that the standard way UBI incentives are delivered—delayed, gain framed, with minimal feedback during the rating period—may not be effective at countering the immediate rewards people experience from using their phones. Pairing frequent, loss-framed

Table 8. Holm adjustment of *p*-values for trial 2 intervention period planned comparisons.

	Contrast	Raw <i>p</i> -value	Rank	Remaining contrasts	Holm threshold	Adjusted <i>p</i> -value
Arm 2 versus Arm 1	1	0.80782822	7	1	0.0500	0.80783
Arm 3 versus Arm 1	2	0.13583109	5	3	0.0167	0.40749
Arm 4 versus Arm 1	3	0.00000894	2	6	0.0083	0.00005
Arm 5 versus Arm 1	4	0.00000001	1	7	0.0071	0.00000
Arm 3 versus Arm 2	5	0.09259734	4	4	0.0125	0.37039
Arm 4 versus Arm 3	6	0.00658333	3	5	0.0100	0.03292
Arm 5 versus Arm 4	7	0.14039619	6	2	0.0250	0.28079

Table 9. Holm adjustment of *p*-values for trial 2 postintervention period planned comparisons.

	Contrast	Raw <i>p</i> -value	Rank	Remaining contrasts	Holm threshold	Adjusted <i>p</i> -value
Arm 2 versus Arm 1	1	0.6519381	7	1	0.0500	0.65194
Arm 3 versus Arm 1	2	0.0446584	3	5	0.0100	0.22329
Arm 4 versus Arm 1	3	0.0039146	2	6	0.0083	0.02349
Arm 5 versus Arm 1	4	0.0000079	1	7	0.0071	0.00006
Arm 3 versus Arm 2	5	0.1230304	5	3	0.0167	0.36909
Arm 4 versus Arm 3	6	0.4317852	6	2	0.0250	0.86357
Arm 5 versus Arm 4	7	0.0602638	4	4	0.0125	0.24106

rewards with social comparison feedback appears to be much more effective.

Trial 2 was designed to create lasting change in participants' habits around phone use while driving. To this end, some participants were given phone mounts and tips for substituting hand-held use with hands-free use, and the intervention period was lengthened to give more time for new habits to solidify. At the end of the intervention period, 9 out of 10 participants who were sent a car mount reported having a mount installed in their car and setting them up for continued hands-free use in the future.

In addition, care was taken to ensure that intrinsic motivation remained high and was not undercut by extrinsic motivators. This included educating participants about the risks of distracted driving, asking them to give their own reason why avoiding hand-held use while driving was important, and letting them freely choose whether to commit to reducing hand-held use. Messaging about potential prize money or insurance discounts also reminded participants that the reason these incentives existed was to encourage driver safety.

The results made clear that providing drivers with phone mounts is insufficient to get them to switch from hand-held to hands-free phone use. However, by additionally getting their commitment to reduce hand-held use, providing weekly habit-building reminders, and introducing gamification and social competition,

researchers were able to create significant changes in drivers' phone use that lasted beyond the intervention period. Adding modest financial incentives amplified the behavior change.

Across the two studies, the most successful treatment led to a sustained decrease in hand-held phone use of 90 s/h, at a per-participant cost of about \$18 (\$7 phone mount, \$6 platinum prize, \$5 leaderboard winnings). Given that the average driver in the United States spends 310 h behind the wheel each year—70 billion h for the population as a whole (Gross 2019)—delivering this intervention at scale could mean close to 2 billion fewer hours of distracted driving per year. Assuming the intervention's effects last for a year, the annual cost would be less than \$1 for every 25-h reduction in hand-held use. Future research should test the long-term efficacy of successful interventions as well as their impact on actual crash likelihood.

Smartphones gave rise to widespread distracted driving but now have the potential to help curb it. UBI programs that reward drivers who put their phones down hold tremendous promise for reducing vehicular accidents. To maximize effectiveness and minimize costs, researchers recommend that insurance companies design their incentives with lessons from behavioral science and provide their customers with the ingredients needed for lasting behavior change.

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