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Text Messaging and Distracted Driving:

Using Voice Dictation to Make Roads Safer

by

Ankur Shah

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Abstract

The dangers of texting while driving (TWD) are widely known. In a time where traffic deaths have been decreasing, fatalities due to distracted driving have been increasing. In 2009 alone, 5,000 traffic fatalities were attributed to cell phone use, roughly 11 percent of all road deaths. Consequently, TWD has caught the public's eye and policymakers' attention. Despite numerous media campaigns and texting bans, TWD is still a contributing factor in traffic accidents. This paper outlines why texting bans have largely been unsuccessful and cannot be realistically enforced. By understanding human behavior and psychology towards TWD, it becomes apparent this predicament reaches beyond simple legislation and a new plan must be proposed. The proposal of using voice-to-text (V2T) technology as a plan is explored in this paper. Examination of driver performance with V2T technology is proven as a potential plan through several studies, suggesting policymakers should focus on creating guidelines for this technology and emphasizing this plan to all drivers.

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Introduction

Texting while driving (TWD) is not a problem. TWD is thought to be associated with 16,000 deaths between 2001 and 2007 (Chester) and is known to increase crash risk by a factor of 23 (Richtel). Despite this, TWD is still not a problem - it is a predicament. Knowing the difference between problem and predicament is the key to understanding TWD, and why TWD must be examined in greater detail.

With a problem, solutions exist that will return the situation to normal levels. When in a predicament, outcomes must be managed, and no plan exists that will return the situation to normal. Implementing solutions for a predicament is counterproductive (Martenson).

Unfortunately, policymakers are treating this as a problem, and believe the solution is to implement regulations. Consequently, by applying a solution to this predicament, policymakers have not seen significant results with regulations. New perspectives need to be formed in order to constrain these statistics before further escalation, and how to manage the outcomes of TWD.

Distracted driving was not always a safety priority. For as long as automobiles have existed, drivers have been performing many activities while driving. Drivers eat, drink, select music, search maps, and self-beautify, among other things. Distracted driving did not reach the limelight until cell phones became heavily prevalent in society. Once drivers started using cell phones, more accidents were being associated with distracted driving. As a result, society started looking at distracted driving as an epidemic.

While using a cell phone while driving has always been concerning, increased texting has caused distracted driving to really take the national spotlight. Tragic stories about loved ones dying in crashes due to TWD have spurred policymakers to pass “emotionally charged” laws, like in Arkansas. Here, the texting ban was called “Paul’s Law” to commemorate a father killed

in a TWD accident (Moritz). 39 states have joined Arkansas and have enacted laws their respective TWD bans, using similar stories ("Cell Phone and Texting Laws").

Anti-TWD campaigns and laws appear to be a logical plan, but this approach assumes driver behavior is easily modified. Many drivers understand the dangers of TWD, but still continue to engage in TWD (PR Newswire).

The way to manage TWD is not in the direction of controlling driver behavior. Rather, if the goal is to reduce TWD accidents, policymakers need a plan that drivers will adhere to. TWD is a predicament unlike any driving behavior noticed before. It would be shortsighted to approach TWD in the same manner as other risky driving behaviors. If policymakers comprehensively analyze all the factors that TWD encompasses, they will find that this predicament cannot be solved with simple legislation. To accomplish this, efforts should focus on making roads safer by making TWD safer. Policymakers can achieve this by collaborating with external parties to foster the development and legislation of voice-to-text (V2T) systems.

By analyzing the factors that contribute to TWD, the findings point to V2T technology having the best outcome. First, the main deterrent used to prevent TWD currently is texting bans. Breaking down the problems associated with enforcing bans suggests laws cannot prevent TWD. This leads into the next section, which discusses how human behavior around mobile phones makes TWD a more complex problem than previously thought. Outlining the rise of cell phones and human psychology towards texting demonstrates why there needs to be a response that approaches TWD differently. These two sections suggest V2T technology to be a viable alternative for manual TWD. Using naturalistic vehicular studies, the conclusion that visual, not cognitive, distractions are the greatest contributor to traffic accidents can be reached. Additionally, this final section uses similar studies to demonstrate how V2T systems are suitable

for normal driving behavior. By examining the predicament from every angle, V2T technology appears to be an effective way to manage this distracting behavior.

I. Texting while driving bans are impractical and ineffective

TWD bans are a relatively new regulation, having only existed for a few years. It started in 2009 when President Obama signed an Executive Order outlining guidelines on texting for all government employees. The Executive Order stated that all government employees need to avoid TWD as a way to demonstrate leadership to states and the general public (Exec. Order No. 13513). In addition to this Order, the National Highway Traffic Safety Administration (NHTSA) held the first national Distracted Driving Summit that year to raise awareness for distracted driving and encourage local governments to adopt tougher laws. Before the late 2009 Summit, less than ten states had any texting regulations. One year after the Summit, 14 states, in addition to many cities, had passed texting bans (Kirby). Today, over 40 states have implemented a texting ban to some degree (See *Texting laws by state* in Appendix). Even as more texting regulations are now in place, many states are having trouble effectively enforcing these laws to decrease the number of TWD accidents.

The notion that texting bans are effective is not completely faulty; there is real world evidence that laws can dramatically reduce TWD observations. In 2010, NHTSA launched a "High-Visibility-Enforcement" (HVE) pilot program in Hartford, Connecticut and Syracuse, New York. The purpose of study was to determine if these programs can reduce cell phone related distracted driving from hand-held use and texting. Throughout 2010, the two cities dedicated $560,000 in media costs for distracted driving awareness and 10,000 man-hours for enforcement for the HVE programs. In each city, these resources were spread over four individual waves. After the programs were finished, Hartford and Syracuse reported a 72% and

32% decrease in TWD observations, respectively (Chaudhary). The program concluded TWD can be reduced through enforcement, but these programs may not be replicable in the current environment.

There are several explanations why HVE programs cannot be replicated throughout every state. Police forces nationwide face disadvantages with enforcing bans due to shrinking budgets. Additionally, apprehending drivers who engage in TWD has been proven difficult. Furthermore, drivers' reluctance to obey bans contributes to the shortcomings of TWD regulations. Finally, the complexities of legislation have made this approach to impede the TWD predicament widely ineffective.

Police forces face difficulties from both internal and external factors

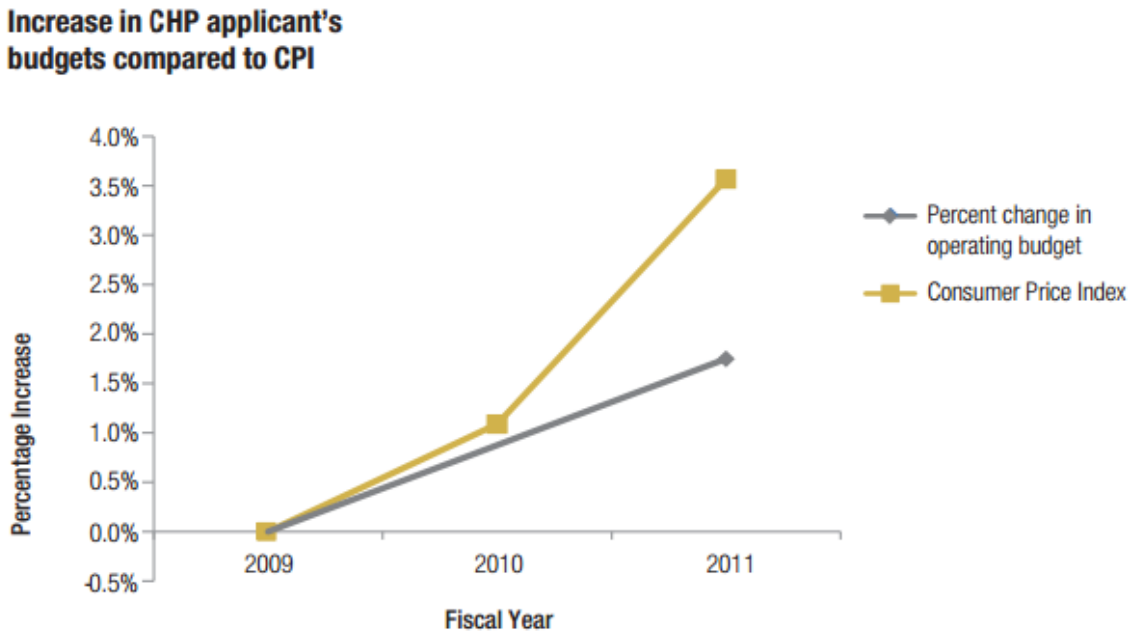
Although police departments in Hartford and Syracuse reduced TWD, the pilot program does not realistically describe what is happening nationwide. First, given the current economic climate, police forces are facing budget and employment cuts. The difficulty of using reduced manpower compounds with frustrations from apprehension of drivers engaging in TWD. There are too many forces working against police departments to duplicate the results seen in the HVE programs.

When the housing market collapsed in 2008, property values decreased substantially, as did property-tax revenues. As this revenue stream dried up, funds available to police departments across the U.S. dropped. Without these funds, departments had to instill hiring freezes or employment cuts (Pearce).

The Police Executive Research Forum (PERF) conducted research in 2011 to measure the impact of the economic downturn on police departments across the country. PERF surveyed 416 agencies and found that 51 percent and 76 percent reported budget cuts in 2011 and 2010,

respectively (*Is the Economic Downturn Fundamentally Changing How We Police?*). Another study by the Community Oriented Policing Services (COPS) looked at how police budgets fared against the cost of living. Although not all agencies reported budget cuts, police agencies overall have not maintained the consumer price index growth, indicated by Figure 1.1.

Figure 1.1



Source: The Impact of the Economic Downturn on American Police Agencies

The decrease in budgets has led to stagnant or shrinking police forces. In an October 2010 police study, 79 percent of city officials reported implementing personnel cuts to meet budget constraints. No agency collects data on the number of police layoffs, but several organizations estimate anywhere between 10,000 and 15,000 police officers were laid off in 2011 (*The Impact of the Economic Downturn on American Police Agencies*).

While the number of layoffs varies, many cities are seeing a substantial decrease in force size. The Paterson and Camden police department in New Jersey had to lay off 25 percent and 50 percent of their officers in 2011. In Flint, Michigan, the department has cut 66 percent of the force between 2010 and 2011 (*The Impact of the Economic Downturn on American Police*

Agencies). While these may be specific incidents, reduced police forces will be unable to enforce texting bans without straining the already limited resources of the department. Jonathan Adkins, a communication director from the Governor's Highway Safety Association (GHSA) commented, "There is not currently a federal pool of money for states to access for distracted driving enforcement much like there is for drunk driving and seat belt use. Until more funding is available, we don't expect states to be able to undertake serious enforcement" ("LaHood, Others Blast Study that Questions Texting Bans"). Given the economic downturn's effect, police departments are unlikely to match the resources used in the HVE pilot programs.

In addition to constrained budgets, police departments are having difficulties identifying drivers engaging in TWD. Keen observation is required to determine if a driver is texting. The main reasons patrol officers are unable observe TWD are as follows: discreetness of TWD, height of drivers in truck based vehicles, and only occasional cell phone use. Additionally, without continuous blanket enforcement, TWD will revert back to pre-enforcement levels.

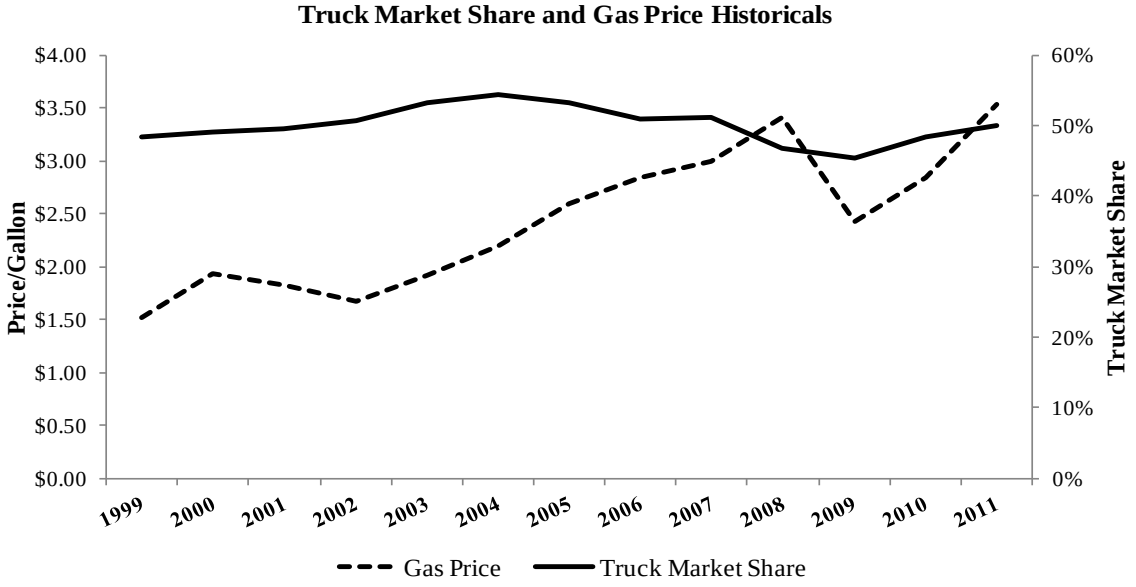
Patrol officers nationwide have expressed their frustrations with patrolling for TWD. An Alton, Illinois police officer mentioned, "I don't know if we've made a single citation. I said from the beginning that it's going to be difficult for us to identify violators." Another officer in the state commented, "The problem with enforcing it is determining what the person is actually doing…if they're holding the phone down where nobody can see it, then we're kind of out of luck" (Clements). With more drivers aware of the TWD laws, drivers are using more caution to conceal their TWD habits.

Motorists who drive truck based vehicles (TBVs) add to the difficulties faced by patrolmen. One police head commented, "Police say it's hard to spot texters on the road… particularly from patrol cars" (Haas). The height differential between a TBV and a patrol car

hinders the officer's ability to observe. Around half of all vehicles on the road have a truck platform. In this instance, truck platforms include crossovers, minivans, Sport Utility Vehicles (SUV), and light-duty trucks (Up to one ton trucks).

As TBVs are not as fuel-efficient as their car counterparts, Americans purchasing of TBVs over the last decade has stayed roughly constant, despite increasing, volatile gas prices. Figure 1.2 shows how gas prices are weakly correlated with truck market share. Although there is a negative correlation between the two sets of data, the correlation coefficient is only -0.15. Truck market share was calculated against total light vehicles sold in the U.S. and gas price was adjusted for inflation against 2011 GDP. Even if gas prices are forecasted to rise in the future, trucks will likely continue to pose a problem to policemen in patrol cars.

Figure 1.2



Source: Average Annual Retail Price of Gasoline
Source: Automotive News

Infrequency of cell phone use while driving makes it hard for police officers to spot drivers engaging in TWD. For most drivers, there is very low chance of getting caught without blanket police coverage on roads. According to the Insurance Institute for Highway Safety (IIHS), drivers spend about four minutes of every hour on the phone, or roughly 7% of driving

time. This low amount of time spent on the phone has made it difficult to actually observed drivers engaging in texting. Additionally, the Institute recorded that 0.9% of drivers could be observed texting in their studies, while 13% of drivers admitted to TWD (Insurance Institute for Highway Safety). This leads to the majority of drivers who engage in TWD to avoid penalties.

A simple hypothetical scenario of 1000 vehicles driving past a stationary police officer demonstrates the magnitude of drivers avoiding penalties. The IIHS data recording 0.9% of drivers observed to be texting can be considered to be a "success rate" and describe a binomial distribution. The distribution can be modeled as $X \sim B(1000, .009)$. In this case, the expected number of drivers caught TWD is nine ($E[X] = 1000 \cdot .009 = 9$).

Using the same IIHS data and logic, 13% of the 1000 drivers engage in TWD. Thus, the expected number of drivers texting is 130. This means 93% (1-9/130) of texting drivers will not be caught, and this number is independent of *N*. Figure 1.3 shows higher "success rates" (% Observed Texting) will still lead to a majority of texting drivers going unnoticed.

Figure 1.3

% Texting While Driving \ % Observed Texting	0.90%	1.00%	1.10%	1.20%	1.30%	1.40%	1.50%	1.60%	1.70%	1.80%	1.90%
9%	90%	89%	88%	87%	86%	84%	83%	82%	81%	80%	79%
10%	91%	90%	89%	88%	87%	86%	85%	84%	83%	82%	81%
11%	92%	91%	90%	89%	88%	87%	86%	85%	85%	84%	83%
12%	93%	92%	91%	90%	89%	88%	88%	87%	86%	85%	84%
13%	93%	92%	92%	91%	90%	89%	88%	88%	87%	86%	85%
14%	94%	93%	92%	91%	91%	90%	89%	89%	88%	87%	86%
15%	94%	93%	93%	92%	91%	91%	90%	89%	89%	88%	87%
16%	94%	94%	93%	93%	92%	91%	91%	90%	89%	89%	88%
17%	95%	94%	94%	93%	92%	92%	91%	91%	90%	89%	89%

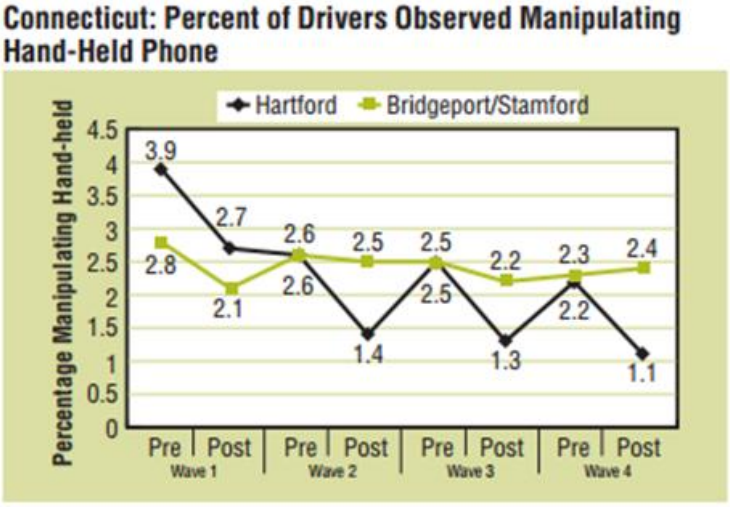
In the NHTSA HVE programs, the percentage of TWD tickets to population was 1.80%, much higher than the rate observed by the IIHS (Chaudhary). Based on Figure 1.3, 85% of drivers who engage in TWD still go unnoticed at the 1.80% "success rate".

Even if bans are properly enforced, continuous and permanent blanket enforcement is required to keep TWD at low levels. After HVE programs are removed, it is likely TWD frequency will revert to its initial levels.

A 2001 study conducted by public policy and behavioral science professors demonstrated that removing enforcement may actually make the situation worse than before. The study tested individuals in situation where probability of enforcement was 0.1, 0.5, and 0.9. The professors found that contract breaches rose when the high probabilities were removed, relative to before. For example, if one group has a probability of enforcement of 0.5, and another group initially has a probability of 0.9 and is then reduced to 0.5, the latter group would exhibit higher amounts of contract breaches (Bohnet). In the case of texting, the probability of enforcement is the chance of being spotted texting, and the contract breach is TWD. The conclusion of the study predicts that the number of texting drivers would increase when high amounts of enforcement are removed.

This phenomenon was observed during the HVE pilot programs. The programs conducted their blanket enforcement through four waves, and recorded observed TWD before and after each wave. As seen in Figure 1.4, observed texting (Manipulating Hand-Held Phone) fluctuated back to initial levels between waves.

Figure 1.4



Source: NHTSA

Although TWD levels did not return to 3.9% before Wave 1, the levels did closely match the control (Bridgeport/Stamford) when blanket enforcement was not present in Hartford.

Another explanation for TWD levels in Hartford matching the control group is the removal of extrinsic motivations for drivers. In this case, the extrinsic motivation is avoiding a fine. The monetary fines used in HVE programs ranged from $100 to $200, depending on the number of offenses for the driver. By placing a monetary fine, the situation changes from a "social" situation to a "monetary" situation.

In a 2011 study in the Journal of Economic Perspectives, three psychologists outlined the effects monetary incentives had on human behavior in the short-term and long-term in a variety of situations.

The article states, "If incentives signal some form of 'bad news,' agents who receive incentives will update their beliefs about the task, their own type, or their assessment of their principal. As a result, their motivation to perform the task without the additional incentive can be reduced permanently" (Gneezy). With the monetary fines, the extrinsic motivation may crowd out intrinsic motivations to not text. This extrinsic motivation may disappear if police departments are unable to properly enforce the bans and funding for these programs falters, leaving no motivation for drivers to avoid texting. As seen in Hartford, the removal of HVE programs and extrinsic motivations brought TWD levels on par with the control group.

Based on these facts, police departments will be unable to recreate and sustain the HVE pilot programs from Syracuse and Hartford. Police budgets are shrinking and will likely be unable to match the resources and funding required by the pilot programs. By foregoing these resources, police forces may not be capable of properly enforcing bans, based on the additional

challenges of identifying drivers engaging in TWD. As a result, HVE programs may have little long term value.

Regulations may actually increase TWD related accidents

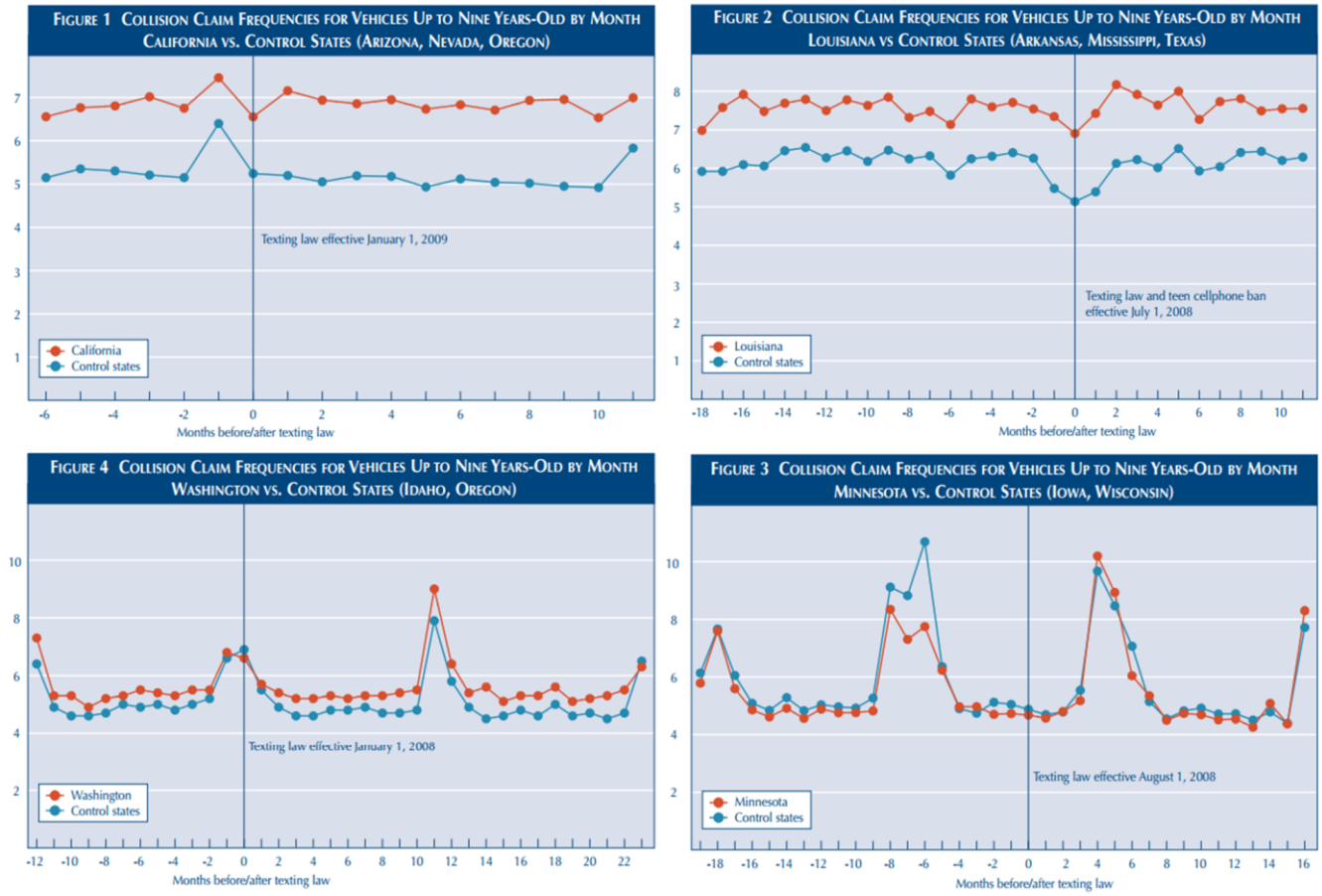
Despite police enforcement unable to control TWD effectively, the assumption that the existence of TWD laws can have positive effects is reasonable. Contrarily, empirical data has concluded these bans have no effect and has made TWD worse in certain states.

While many states have varying levels of texting bans for drivers, most are finding very similar accident rates before and after enactment of TWD bans. Also, the difference between states with bans and without is negligible. In 2010, the non-profit IIHS subsidiary Highway Loss Data Institute (HLDI) compared TWD crash rates of states with bans to nearby states without bans. HLDI found no differences between the states before and after the bans took place (Dennis).

Over the years 2007 and 2009, the HLDI collected national data from insurance companies on 3,313,507 collision claims and examined four variable (implemented texting ban) states: California, Louisiana, Minnesota, and Washington. HLDI examined collision claims that were related to TWD.

In addition to examining results before and after the texting bans, HLDI compared collision claims between each variable state and nearby control states (no texting laws). By juxtaposing the variable states with the control states, HLDI was able to account for any discrepancies such as economic downturn, change in miles driven, climate, etc. Figure 1.5 shows how the variable states (red) compared to the control states (blue).

Figure 1.5



Source: HLDI Bulletin Vol. 27, No. 11

The graphs track the proportion of collision claims due to texting to every hundred claims and show no statistical difference between the period before and after the start of the texting ban. When compared to the variable states, the control states almost had the same pattern of texting collision claims. The study concluded that texting bans were ineffective in reducing the proportion of texting related collisions (*Texting Laws and Collision Claim Frequencies)*.

Another conclusion by the study indicated that texting bans may actually increase collision rates. Adrian Lund, president of HLDI, said, “Texting bans haven't reduced crashes at all. In a perverse twist, crashes increased in 3 of the 4 states we studied after bans were enacted. It's an indication that texting bans might even increase the risk of texting for drivers who continue to do so despite the laws,” (“LaHood, Others Blast Study that Questions Texting Ban”).

This trend is known as the “Law of Unintended Consequences”. The law states that actions by people always have unintended and unanticipated effects. This concept appears frequently when explaining the unintended effects of many government interventions. For example, in a hypothetical situation where the government sets an import quota on steel, it is done to protect domestic steel companies from cheaper foreign competitors. While this helps steel companies, domestic automakers must purchase more expensive local steel. Domestic automakers now have a tougher time competing with foreign automakers with access to relatively inexpensive steel. As a result, this policy helped one industry, but had an “unintended consequence” of hurting another (Norton).

Although the quota is different than texting bans in many aspects, there are still common underlying themes. Instead of people abiding to the texting ban, drivers are now placing their cell phones lower in their car to avoid getting caught. As drivers have moved cell phones lower to avoid detection, distraction has actually increased, thus causing an “unintended consequence” (Copeland). Drivers lowering their cell phones out of view could explain the reduction in TWD observations, not drivers stopping TWD, during the HVE pilot programs.

It is also possible these results may actually be understated due to “social desirability bias” (SDB). SDB occurs in a survey when individuals have the tendency to “present themselves in the most favorable manner relative to prevailing social norms” (King). For example, in a drug survey, a respondent may believe drug use to socially unacceptable, but still recreationally use drugs. If the individual responds as never having used drugs, the survey would be a victim of SDB.

TWD can be considered to be a socially undesirable behavior as 93 percent of U.S. drivers believe it to be dangerous (Ford Motor Company). In addition to being undesirable,

claimants may avoid admitting texting played a role in the accident, fearing any legal penalties. If such is the case, the negative impact of TWD bans may actually be underestimated in this study.

Implementing TWD bans without foreseeing future consequences is haphazard. The HLDI study proposes that the increase in TWD claims is attributed to drivers concealing their behavior to avoid detection. Consequentially, drivers have actually become more distracted and the predicament may become worse.

Complexity of TWD legislation is too inefficient to ever be used effectively

The intricacies of TWD bans are another source of frustration for law enforcement officials. Many states with TWD laws have subsections based upon age, type of driver, which phone functions were being used, and if the driver was exhibiting signs of recklessness. As a result, police forces must be even more diligent in their duties. These ill structured laws may also explain the limited apprehension of TWD drivers.

By having TWD laws that discriminate against novice drivers, police officers must make the effort to ensure proper age. When observing TWD, the police officer must judge whether the driver falls under the age banned from TWD or not. With TWD observations already below one percent, these stipulations make bans seem almost unenforceable.

Additionally, the exclusion of other cell phone functions is making enforcing the texting bans more complicated for patrol officers. In states that do not have complete cell phone bans, some texting bans still allow drivers to use phones in ways that do not involve messaging. These uses include Facebook, Twitter, web browsing, mobile games, and others which may be as, or more, distracting than messaging. Similar to determining a driver's age, patrol officers must meticulously examine drivers to see if he or she is actually texting or using a different phone

function. As one police chief from Massachusetts stated, “It's a difficult law to enforce because it's difficult for an officer to distinguish between someone texting and dialing” (Bock).

If an officer does believe a driver to be texting, he may have trouble proving the driver was in fact texting and not using a different phone function. A driver who is pulled over may be untruthful and claim he was dialing a number or using a different feature. Unfortunately for the officer, the burden is now on him to prove the driver was texting. In order to prove the driver was, in fact, texting, the patrol officer must procure a search warrant to examine the driver’s phone.

These burdens have caused very few tickets to be handed out. In Georgia, where TWD is a primary offense for all drivers, state troopers have handed out 11 citations per month, on average (Simmons). In Kentucky, 144 TWD citations were handed out in the first year the ban went into effect (Moxley). Massachusetts has cited one TWD ticket for every 200 speeding tickets (Moskowitz). While states have had varying results based on their diligence, the structures of bans may discourage police officers from actively enforcing TWD bans.

To fix this problem, TWD bans should be more concise in their structure to be properly enforced, which will not allow drivers to avoid penalties based on technicalities. Additionally, these laws may be further strengthened by increasing penalties for TWD. Whether or not this is true, policymakers will likely be unable to change current laws due to the legislation environment.

It may seem impressive at first that almost 40 states promptly passed TWD laws over two years, but much of this quick legislation may have been influenced by reduction in federal funding for states.

In July 2009, Senator Charles Schumer (D-NY) introduced the ALERT (Avoiding Life-Endangering and Reckless Texting) Drivers Act, which meant states would lose 25% of their federal highway funding if they did not levy penalties for drivers that engaged in TWD (ALERT Drivers Act). Although this bill did not pass, there are still some telling inferences of this bill.

First, this is providing an extrinsic motivation to state policymakers to pass the desired legislation. Even though the bill did not make it through, state policymakers may have pushed texting legislation, fearing federal funding penalties. Without this extrinsic motivation to pass future bills, states would be much slower to make amendments to their texting policies. This effect was seen in the 1980s when a federal bill was passed to reduce funding for states without strict drunk driving laws (Freeman).

Second, this bill not going through indicates the majority of policymakers may not believe that TWD deserves harsh penalties. As shown by the previous HLDI study, the current fines have not deterred drivers from texting. By determining a loss of 25% of federal highway funding to be too harsh, there could be a sentiment shared across policymakers that TWD is not a severe enough offense to warrant more serious penalties.

Pure economic theory predicts incentivizing or levying penalties would always result in the desired behavior. In the case TWD, this effect is null, and in some cases causes perverse results. TWD bans face obstacles from police enforcement, drivers, and even its own legislation. To believe that TWD can simply be controlled by bans and penalties would be short sighted. Policymakers must realize that the grip texting has on America and factors involved are much greater than previously thought.

II. Trends in texting and human behavior will make this epidemic much harder to fix

Ray LaHood, former U.S. Secretary of Transportation, responded to the HLDI study, “For example, we have a national law against drunk driving. People are also required to wear seat belts. But if the number of fatalities in a state goes up one year, would it now pass as ‘research’ to say that seat belt and anti-drunk driving laws are to blame?" (Heussner). While the HLDI study only covered a two-year span, TWD is completely unlike drunk driving and seatbelt usage. Even if the research is too early to be conclusive, general human behaviors will likely make TWD worse in the future.

The similarities between TWD, drunk driving, and seatbelt use are highly limited

The results from drunk driving and seatbelt programs have not been perfect, but the U.S. has seen significant, positive results since their inception. However, TWD and the former driving behaviors happen to be much different.

Strong efforts to reduce drunk driving have been going on for the last 30 years as pressure from advocacy groups such as Mothers Against Drunk Driving (MADD) has built up. There were drunk driving laws before this, but the previous laws were vague and simply prohibited “driving while intoxicated”. The punishments for breaking these statutes were often very light, even for repeat offenders. As these advocacy groups came down on policymakers, in addition to insurance companies and threats of decreased federal funding, every state created strict drunk driving laws with harsher penalties and more enforcement (Freeman).

These laws have been successful due to strong laws and enforcements. Punishments for drunk driving include monetary fines, jail time, and even criminal record implications. Also, police forces have a variety of tactics to catch drunk drivers. Patrol officers are able to apprehend drunk drivers through observation and tactical checkpoints in areas where alcoholic consumption

is likely. Conviction of these crimes is straight forward, as patrol officers can administer a breathalyzer test or perform a field sobriety test. This accompanied with witness testimony makes the conviction rates for drunk drivers around 90 percent (Jones). Figure 2.1 shows how the efforts to curb drunk driving have proven to be successful.

Figure 2.1

Source: Alcoholalert.com

The rate of alcohol related fatalities has dropped by 33% over the last thirty years. Although the share of drunk driving related fatalities has hit a plateau at 38%, it is unarguable that the strong laws and penalties have been successful to a degree.

Policymakers have taken this same logic with seatbelt usage also. By creating programs such as "Click it or Ticket" in combination with strong enforcement, the U.S. saw its seatbelt usage rate in 2012 rise to 86% (Barnett).

These two programs may have had their limitations, but they are going in the right direction. Unfortunately, the same logic cannot be easily transferred to texting and driving. There are the obvious differences between TWD, drunk driving, and seat belt use. As stated earlier,

spotting TWD is a much more difficult task than catching drunk drivers and drivers without seatbelts. In addition to this problem, the time drivers spend texting is very low, unlike drivers always being seen without a seatbelt or drunk drivers continuously driving erratically.

One similarity between the three forms of reckless behavior is the existence of a natural level of noncompliance. While laws can deter individuals from engaging in undesirable behaviors, they will never reach 100 percent compliance. Already, the percentage of accidents due to drunk driving has stopped decreasing. Between 1997 and 2009, drunk driving accidents caused 39 percent of all traffic accidents (Alcohol Related Fatalities). In the early 1980s, seatbelt use was around 14 percent (Hedlund). By 2005, seatbelt use had reached a level around 82 percent, where it has stayed since (Pickrell). No matter what rules or regulations are implemented, there will always be a natural level of noncompliance. A specific strategy can only reach a certain level of success.

The same concept can be applied to TWD, but it is too early to tell where this plateau will be. Laws are in their early stages and texting is still a relatively new phenomenon. The HLDI studies showed this level has not been affected by texting laws, as TWD related accidents have not changed. Furthermore, many surveys have been released and each has reported a wide discrepancy between the percentages of drivers that engage in TWD. In 2011, NHTSA reported that 18 percent of drivers engage in TWD, with 49 percent of drivers aged 21-24 engaging in this behavior (Chaudhary). In a 2010 survey by the Pew Research Center, 27 percent of adults admitted to TWD and 26 percent of teens admitted to TWD (Madden). On the far extreme, a survey done by the Federal Communications Commission found that 50 percent of teenagers engage in TWD (FCC). One possible explanation is these surveys suffer from SDB to different

degrees. While there is no established level of compliance, the discrepancies between surveys could indicate the level of noncompliance is higher than previously thought.

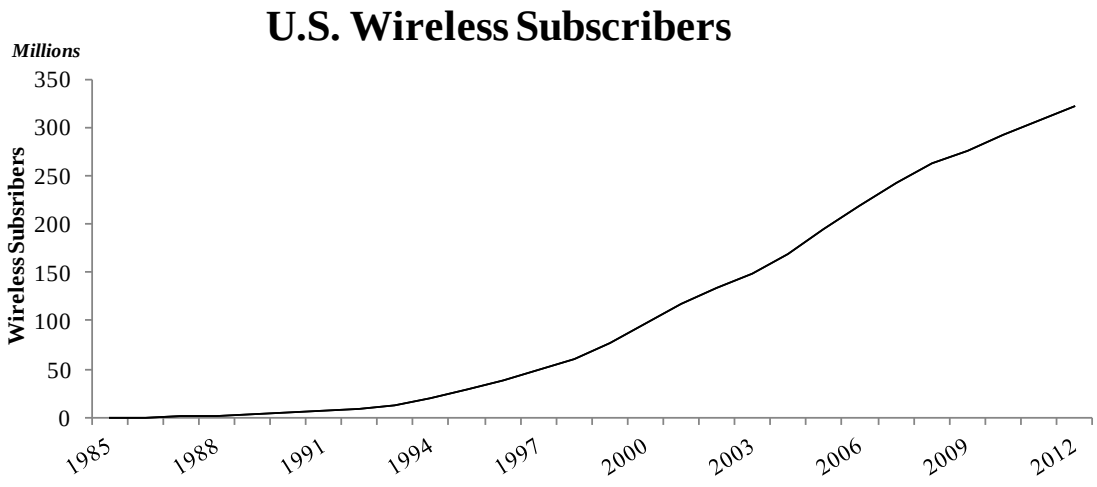
The similarities between the reckless behaviors appear to be limited. The difference between seatbelts and texting is the fact that seatbelts are largely not inhibitive, while texting provides the user with some utility. While it is reasonable to compare compulsive TWD to excessive drinking, the fact of the matter remains, texting is much more wide spread than drinking.

Ultimately, two biggest drivers that set TWD apart from seatbelt use and drunk driving and make it a much more complicated situation, are the rapid increase in texting and human behaviors around this new form of communication.

Increased cell phone usage has changed how we communicate

The advent of the cell phone has completely changed the way Americans communicate with each other. As cell phones have proliferated society more and more each year, Americans now have the expectation that anyone can be reached at any time of the day. Cell phones have now become the preferred way to instantly communicate.

Figure 2.2

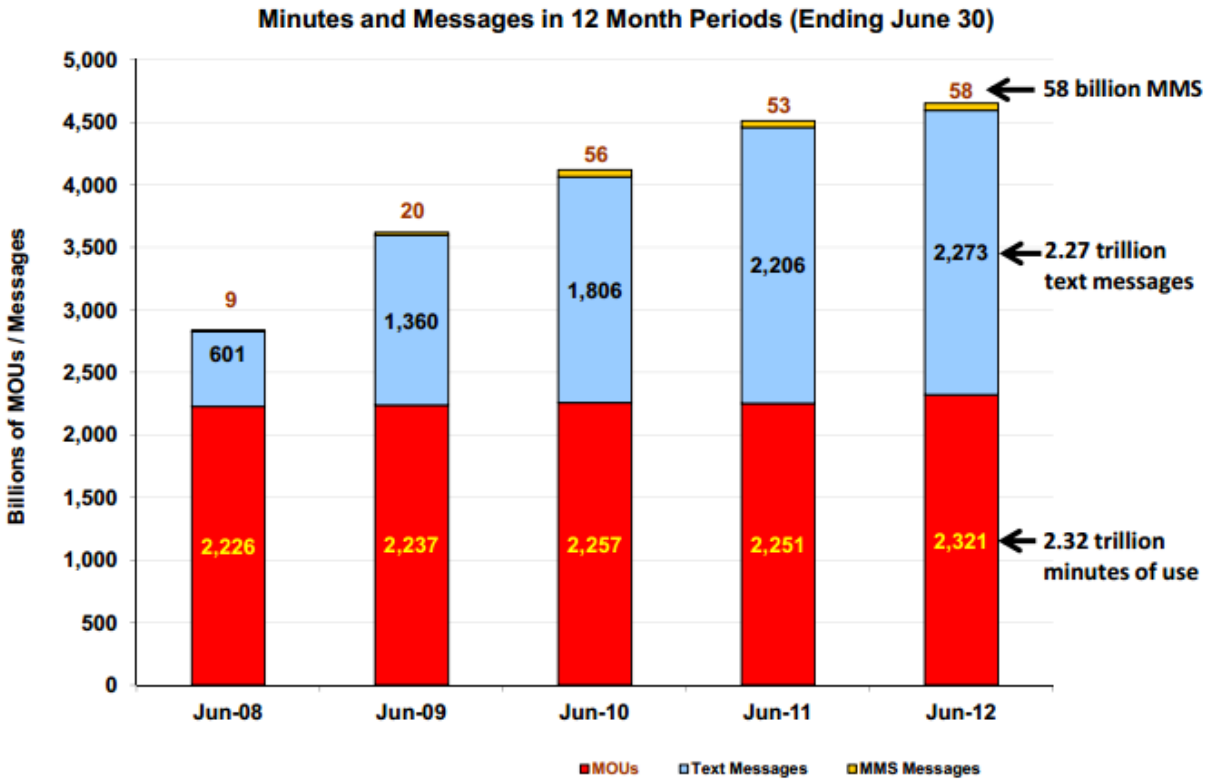


Source: CTIA

As shown in Figure 2.2, cell phones been adopted by almost all Americans. As the number of subscriptions now outnumbers the total population, Americans are starting to have multiple subscriptions for different purposes. Cell phones are becoming more and more important to Americans, as landline use has decreased substantially (Reisinger).

Not only have cell phones changed what Americans use to communicate, but also changed how Americans communicate with each other. With the growth of text messaging, Americans now prefer this method to reach out to contacts. Figure 2.3 quantifies how much Americans are texting annually. For simplicity, a Minute of Use (MOU) is equal to one text.

Figure 2.3



Source: CTIA

While number of minutes spent on the phone stays level, the number of text messages has been growing substantially each year. The graph demonstrates two key changes. First, the amount at which Americans communicate with each other is increasing, and the percentage at

which Americans text is increasing. From 2008 to 2012, the share of MOU decreased from 78% to 50% and the share of texts increased from 21% to 50%. In the period ending June of 2012, 2.27 trillion text messages were sent out (*Wireless & Wireline Industry Comparison Report Mid-Year 2012*).

By using this number and the number of wireless subscriptions, each subscriber pushed out almost 20 texts a day, compared to only 6 texts a day in 2008. While this may not seem very high, this average carries a very high variance. Younger demographics tend to be on the higher extreme and will have definite implications in the future, which will be discussed later in this paper.

Driver mentalities make TWD very dangerous

Besides the acceleration of cell phone use and texting in society, drivers' behaviors around TWD are reason for extra concern. In the current driving environment, drivers may be giving themselves a false sense of confidence.

The trend of overconfidence has been augmented as vehicles have become increasingly safe. Vehicles have benefitted vastly from both safety mechanisms during collisions and advanced systems where a vehicle can "read its surroundings".

Safety mechanisms in vehicles today include seatbelts, airbags, laminated windows, crumple zones, and rollover prevention. When airbags first debuted in the 1970s, they were very basic at best, providing airbags for only the driver. Now in 2012, vehicles are carrying up to 12 airbags. In addition to multiple airbags, vehicles now have the ability to adjust the airbag's deployment to the occupant's size.

Compounding on the safety mechanisms, vehicles are now becoming more "intelligent". While safety mechanisms can help reduce the severity of a crash, Advanced Driver Assist

Systems (ADAS) are features that prevent crashes. Examples of ADAS features include: lane departure warnings, blind spot detectors, adaptive cruise control, and automatic braking. These systems have proven to be so successful that, even in early stages, ADAS can reduce crash risk by 42 percent (Vandezande). These perpetually improving safety systems and ADAS together may entice drivers to engage in risky behavior, as the stakes have been lowered.

Risk Compensation theory states that people will adjust their behavior to the perceived level of risk. A 2006 study that examined the effects of the "offset hypothesis" stated:

> The offset hypothesis predicts that consumers will adapt to innovations that improve safety by becoming less vigilant about safety. They will, for example, drive faster in cars that are equipped with extra protection features, ride on dangerous off-road trails when wearing a bicycle helmet, leave hard-to-open (childproof) bottle caps off medicine containers, pay less attention to infants in bath seats that are intended to prevent drowning, and even take fewer precautions to prevent children from having access to cigarette lighters that have a safety device.[1]

This hypothesis can be applied to wide variety of circumstances, but the study looked at effects of improved airbags and antilock brakes in vehicles. To analyze the effects of these safety mechanisms, the study developed an empirical test for the efficiency of airbags and then extended it to antilock brakes. The study found that drivers maximize their utility function, or indifference curve, based on a linear relationship between the probability of being injured in an accident and driving intensity.

It concluded that safety improvements of these devices are offset by drivers engaging in more risky behavior such as speeding. The study then hypothesizes that risky behavior will continue to increase as ADAS has a greater presence. In the case of TWD, drivers may engage more in this risky behavior because the risk is offset by the improved safety systems.

[1] Winston, Clifford, Vikram Maheshri, and Fred Mannering. "An Exploration of the Offset Hypothesis Using Disaggregate Data: The Case of Airbags and Antilock Brakes."

This increased confidence in safety is further augmented by drivers' belief in the superiority of their driving skills. This outcome is known as the "Lake Wobegon Effect" (LWE). Lake Wobegon is a fictional town in Minnesota where "all the children are above average", hence describing the human tendency to believe that one's abilities are superior to others.

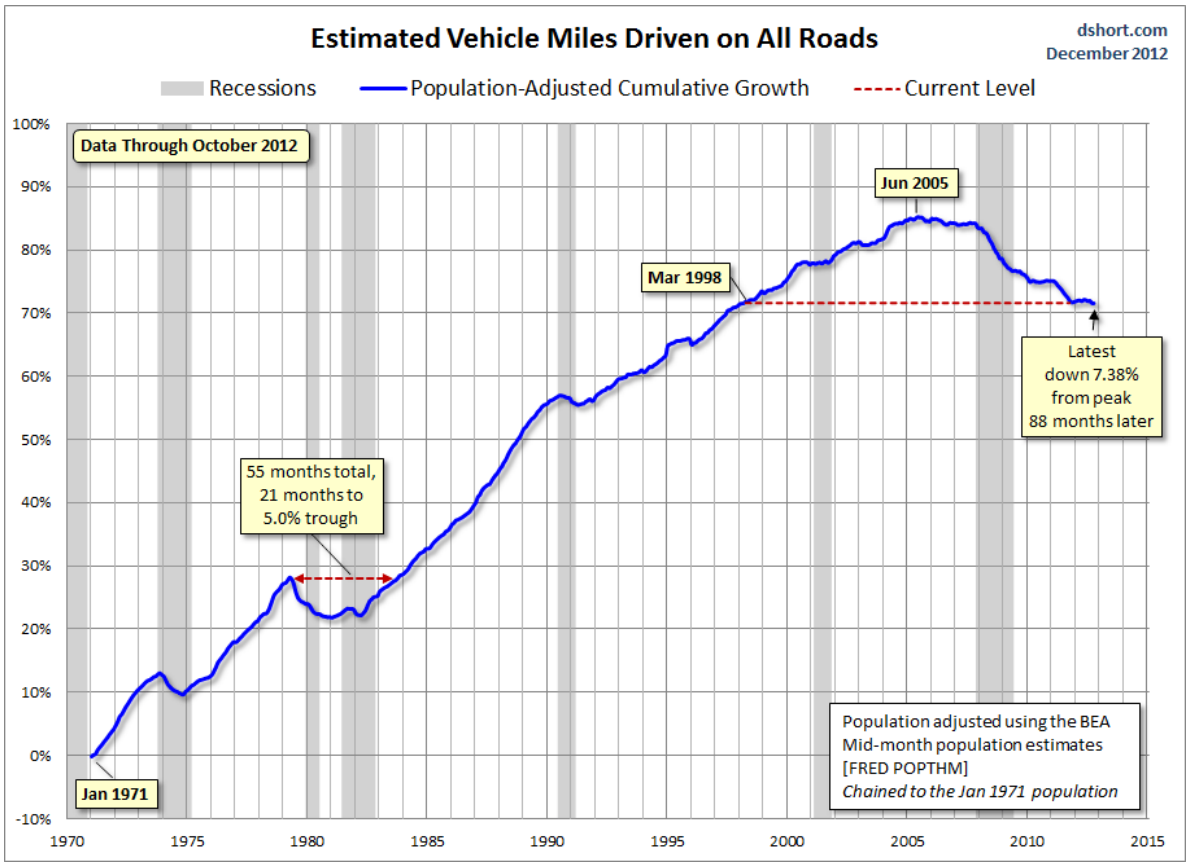
In 2011, PR Newswire, along with The Harris Poll, found that despite knowing the risks of TWD, drivers continue to text. When asked about their beliefs on the dangers of TWD, 91 percent of respondents described TWD as "dangerous". Despite these beliefs, 22 percent openly admitted to TWD. Based on the SDB, there may be reason to believe this number may actually be higher.

The poll believes that the LWE is the reason that many drivers still continue to text. They found that many drivers believe their driving abilities are above average. When polled about their driving abilities, 57 percent believed they were above average, 42 percent believed they were average, and only 1 percent believed there were a below average driver. The implication of this is, despite many people knowing about the risks of TWD, drivers believe their above average driving abilities will keep them out of danger (PR Newswire).

The effects of these driver behaviors will increase, as the amount of miles travelled has generally increased annually over the last four decades. This combined with longer commutes will create an environment where waiting to read or write a text will be much harder. The group especially susceptible to this trend is drivers on a work commute.

Over the last several years, the amount of miles travelled, adjusted for population, has actually decreased. Figure 2.4 shows the miles driven adjusted for total population of individuals older than 16. For clarity, the blue line at 72 percent in 2012 represents a 72 percent increase in total miles driven since 1971.

Figure 2.4



Source: Advisor Perspectives

Even though the growth of population adjusted miles driven has been decreasing since 2005, growth normally occurs when the economic environment is favorable. The gray intervals on the graph represent economic recessions. The declines in growth relative to previous years occur mostly in the gray intervals. As of January 2013, the economic environment is still not favorable, hence the continued decrease in relative growth. Besides poor economic times, other factors that contribute to this decrease include volatile gas prices, ability to work at home, and unemployment (Short).

For those who are employed, the uncertainty in the job market has created a new group of laborers called “Super-Commuters”. A super-commuter is defined as “a person who works in the central county of a given metropolitan area, but lives beyond the boundaries of that metropolitan

area, commuting long distance by air, rail, car, bus, or a combination of modes". This is a growing trend with substantial growth occurring in eight of America's largest metropolitan areas. The report also stated that most super-commuters are below 29 years of age. Figure 2.5 shows the staggering growth rates from 2002 to 2009 of the top five of the ten largest metropolitan areas.

Figure 2.5

Top 5 U.S. Counties Among 10 Largest Metropolitan Workforces in U.S. by Rate of Growth in Super-commuters, 2002-09	
1) Harris Co. (Houston), TX	98.3% increase
2) Los Angeles, CA	76.7% increase
3) King Co. (Seattle), WA	60.4% increase
4) Manhattan (New York City), NY	60% increase
5) Philadelphia, PA	49.9% increase

Source: Moss

Besides uncertainty in the job market, workers may have been able to adjust to long commutes because of the ability to always stay connected. Transportation is not looked at as "downtime", but another time of day where workers can still be productive.

As workers are increasing commutes to and from work, drivers will have difficulty staying off the phone for the duration of the trip. Super-commuters will tend to drive during peak traffic times, so suppressing the urge to text may be harder, especially since most of the super-commuters tend to be younger. Even as miles per person driven have decreased, the poor economic conditions have created this new group that is more susceptible to TWD (Moss).

Human psychology exhibits semblances of texting addictions

The increased use of texting is believed to be creating negative mental health issues in society. Texting is still relatively new; much research on mental health is still developing. While compulsive texting may seem like an addiction or mental disorder, normal brain processes may

be the culprit of this behavior. Regardless of opinion, many individuals are having difficulties resisting the urge to constantly text.

One of the main reasons people seem to continuously text is because of the excess dopamine the brain produces while texting. Dopamine causes individuals to seek out information and stay curious. Dopamine complements another brain chemical, opioid, which causes individuals to experience enjoyment. "The wanting system propels you to action and the liking system makes you feel satisfied and therefore pause your seeking."

Dopamine is very influenced by "unpredictability". When timing of information is uncertain, such as texts or emails, dopamine levels are actually elevated, causing individuals to seek out the new information. It is also very sensitive to "cues" of new information being available, such as an alert for a text message. Finally, dopamine levels rise especially when the information is relatively short. The nature of texting describes these factors, hence the reason individuals have large impulses to check their phone when a text arrives (Weinschenk).

In addition to the brain wanting to find new information, people are compelled to read and write texts instantly because the value of information diminishes over time. To test this theory, a 2012 study at the University of Kansas was done to determine the effects time delay has on information value.

The study asked participants a series of decisions in two types of scenarios. The first scenario was purely monetary. Participants were asked to choose between receiving a smaller amount of money immediately or a fixed larger amount ($100 or $1000) after a variable amount of time. In scenario two, participants chose between receiving a small amount of money and information (a text message) now, or a fixed larger amount of money ($100) and the information after a variable delay.

To analyze the results of the decisions, the team calculated indifference points for each delay. The indifference point represents the point where the value of the immediate prize was equal to the delayed prize. That is, the indifference point would be represented when a certain amount of money now would be equal to receiving the larger amount of money later.

Both scenarios had similar results. The indifference point decreased as the length of delay increased. This means the immediate value of the delayed, fixed amount of money decreased as the delay lengthened. Both scenarios have similar qualitative behaviors, as shown in the graph below. The time difference between the scenarios is vastly different, as the scenario without the information was over days, and the scenario with the information was over minutes. To examine all scenarios together, the data was normalized to fit on Figure 2.6.

Figure 2.6

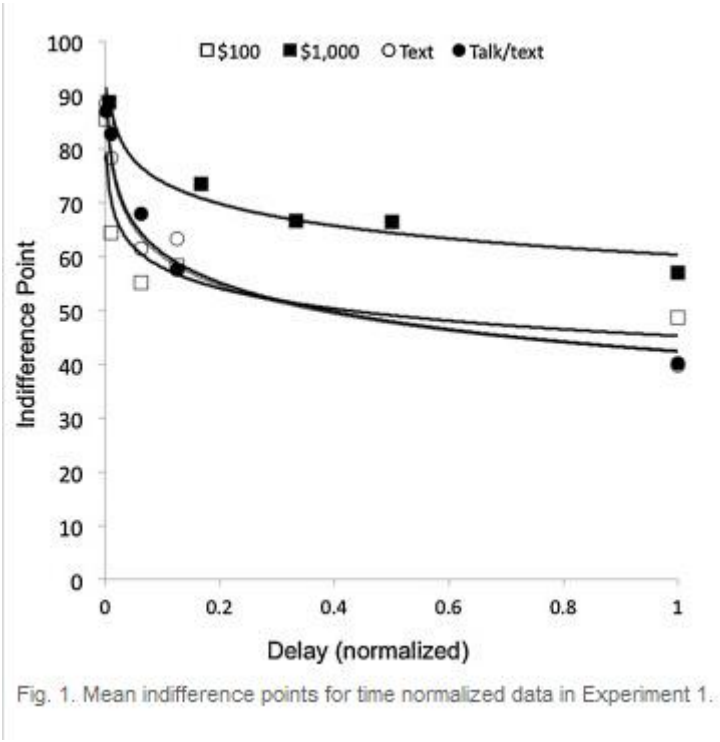


Fig. 1. Mean indifference points for time normalized data in Experiment 1.

Source: Atchley

The squares represent the scenarios where no information was involved, and the circles represent the scenarios with information. The indifference points for the scenario with the delayed $1000 reward were normalized to a $100 scale.

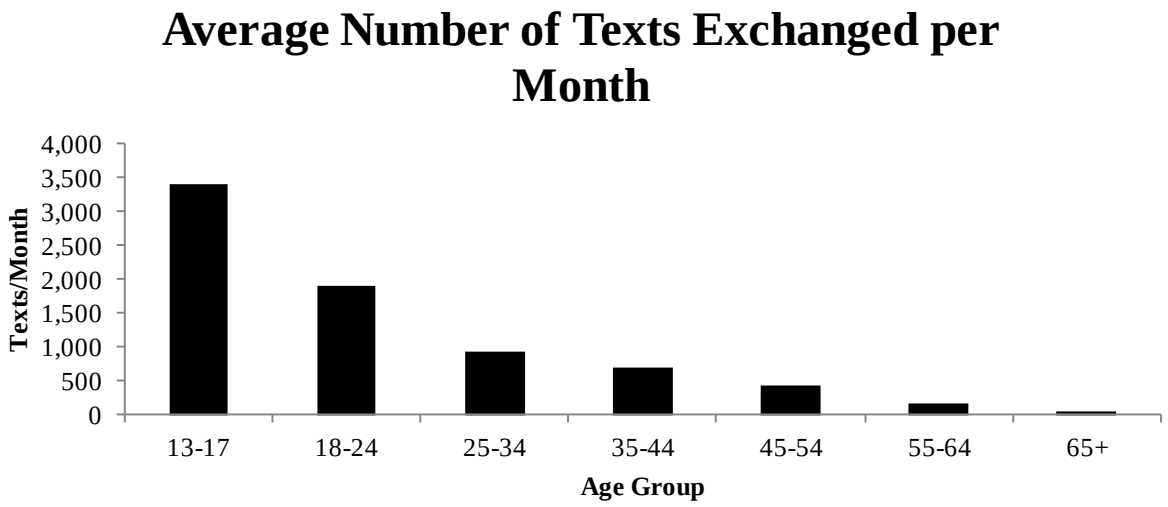
While it is apparent that money and information lose value as the delay is increased, the value decays exponentially in the beginning. The graphs may be qualitatively similar, but the durations to lose the same amount of value are drastically different. In the scenarios without information, $1000 delayed reward lost 25 percent of its value in two weeks. In the scenarios with information, the $100 delayed reward lost 25 percent of its value in 10 minutes. This finding illustrates how individuals need to check their phones instantly because of the rapid decrease in information value. Thus, waiting to check messages on a phone may not be realistic for many drivers (Atchley).

As compulsive texting may not be seen as an addiction, the mental processes cause individuals who text to exhibit symptoms similar to addictions. The effects of dopamine in the brain and accelerated loss in information value are major factors as to why people need to continuously text and text instantly.

The role of teenagers within TWD creates additional problems

TWD may seem manageable now, with only around 20 percent of drivers admitting to texting. The reality is TWD may become substantially worse because of the role teenagers have with texting. Texting appealing to mostly teenagers creates a twofold problem due to lack of driving experience, and habits that will last for their life. Figure 2.7 shows just how large the disparity between age groups and texting amounts is.

Figure 2.7



Source: The Nielsen Company

The leading cause of death for teenagers is by automotive accident, where between 5,000 and 6,000 teenagers are killed each year. The crash rate among drivers 16- to 19-year-olds is almost four times higher than that of older drivers. In addition to lack of driver experience, reckless driving makes the crash rate disproportionally high compared to experienced drivers (Allstate).

On top of texting having a large prevalence with teenagers, this age group engages in TWD considerably more than other age groups. Vlingo, a voice-to-text (V2T) software company, conducted a study in 2010 to examine the attitudes towards TWD. Part of the survey included breaking TWD rates for each age group. Across all age groups, 35 percent of drivers admitted to texting. For drivers between ages 16 to 19 and 20 to 29, 50 percent and 62 percent admitted to TWD, respectively. While these TWD numbers may be inconsistent with other studies, there is a trend that teenagers and young drivers engage in TWD in the largest numbers. This is despite many texting bans targeting novice drivers and young drivers knowing the risks of TWD (*Texting While Driving in America 2010*).

With so many teenagers engaging in TWD, it may seem like this situation is limited to young drivers. Although excessive texting and TWD is more common among younger drivers, there is reason to believe these habits will be heavily found across all age groups in the future.

The habits picked up in the last stage of adolescence (18-23) have the greatest chance of staying with the individual. “What last stage adolescents discover is that good habits are hard to start (that takes "will" power), and bad habits are hard to stop (that takes "won't" power.) In each case they find that habit change is resisted because people are so deeply invested in their own status quo” (Pickhardt). As teenagers who engage in TWD and heavy texting enter into adulthood, this research indicates that these habits are likely to stay. Even though TWD may seem concentrated in teenagers, this predicament will grow if teenagers continue this behavior as they grow older.

In consideration of teenagers playing a large role in TWD, many educational efforts are being directed towards this age group. Surprisingly, a 2010 study of 673 young adults showed that using “fear messages” to change behaviors may cause individuals to engage in TWD more, creating “a boomerang effect.” Explanations for this include young adults becoming angry over having personal freedoms taken away and having been desensitized to graphic images. The researchers also noted that young adults were more susceptible to fear messages that contained legal detriments. With enforcement of TWD bans very low, this may explain why fear messages have little effect on teenagers (Lennon).

Policymakers may believe that TWD can be approached in the same way as drunk driving and seatbelts. The human dynamics and proliferation of TWD across Americans make this situation much more complex. Plans such as laws and educational programs may not be

enough to deter drivers from TWD. A more efficient approach to curb this behavior before it escalates would be considering an idea that accounts for all of these factors.

III. Voice-to-text technology (V2T) is a viable strategy to reduce TWD accidents

Texting has become so engrained in society and has many psychological effects, that regulation and education are not efficient. Instead of working to eliminate TWD, policymakers should consider making TWD safer. Therefore, policymakers should encourage hands-free voice-to-text (V2T) systems, rather than relying on TWD bans.

State legislatures believe prohibiting all distractions within vehicles is the answer to reducing driver distraction. While cell phone restrictions between states vary, some states have banned all mobile phone use, such as California, New Jersey, and Nevada (GHSA). The National Transportation Safety Board (NTSB) suggests states should now expand their regulations farther to include Hands-Free Technology (HFT) (Woodyard).

A publication by the National Safety Council (NSC) concluded that hands-free devices provide no safety benefits. The NSC compiled more than 30 research studies and reports from various institutions to answer two questions: is HFT safe and what makes HFT just as dangerous?

HFT is considered as dangerous as hand-held phones because the cognitive distraction is still present. It may seem safer because visual and manual distractions are eliminated, but cognitive distractions contribute the most to driver inattentiveness.

The reason is the brain cannot handle processing multiple tasks; it is a myth that brains can multitask. Instead of performing tasks simultaneously, the brain processes activities sequentially. Also, while performing tasks concurrently, the tasks are not competed at optimal focus. This is why simply conversing with an external participant while driving is distracting,

regardless of hand-held or HFT. While in phone conversation, drivers fail to process 50 percent of visual information, thus slowing reactions (*Understanding the Distracted Brain*).

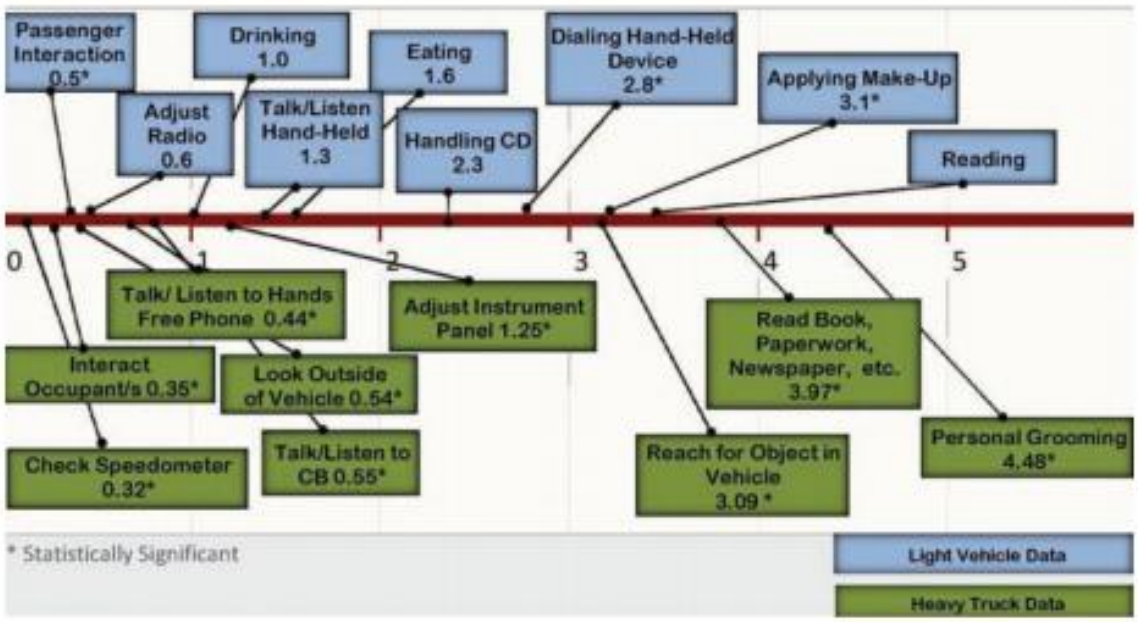
The risks of hands-free technology may be overstated

While holding conversations can be distracting, completely dismissing HFT would be shortsighted. Instead of looking at how distracting HFT is, another perspective would examine how HFT affects crash rates.

To quantify the crash rates, researchers conducted a 100-Car Naturalistic Driving Study to determine what actually happens with distractions. Many studies have been done over the last two decades on distracted driving, but these studies were conducted through simulators or through epidemiological analyses. Simulators can quantify distractions well, but the "task-based" performance and results do not exactly replicate the actual driving environment. With epidemiological studies, analyzing collected accident data may have shortcomings, as documentation of accidents may not account for all factors. Instead of relying on lab tests and post hoc accident reports, naturalistic studies collect data from the actual environment in real time. Unlike the former two sources of data, naturalistic studies can better quantify crash rates caused by distractions more similar to the actual driving environment.

In naturalistic studies, vehicles are equipped with sensors and cameras to monitor how drivers operate in normal conditions. The sensors are used to detect crashes and near crashes, while the cameras are used to monitor driver behaviors. After equipping 100 vehicles with these systems and collecting data over two years, the study determined crash probabilities for various driving distractions. While 100 cars may not be a large enough sample, the results do have telling inferences. Figure 3.1 shows a metasummary of driving distractions and the odds of crashing.

Figure 3.1



Source: Estimating Crash Risk

The upper portion of the summary shows the crash and near-crash risk for light vehicles (i.e. vehicles lighter than 1-ton trucks). This portion reveals that visual-manual tasks such as dialing, applying make-up, and reading statistically increase the risk of crashing. On the other hand, tasks without visual components such as, talking/speaking on the phone, eating, or drinking do not statistically increase crashing risk. For the Heavy Truck data, the same trend that visual-manual tasks increase crash risks is present.

Even more telling is that this data shows HFT technology may be relatively safer (odds less than one) than simply driving, as seen by the Heavy Truck data for "Talk/Listen to Hands Free Phone". While sufficient data was unavailable for Light Vehicles, this finding may be replicated with a larger Light Vehicle sample size. The researchers hypothesize that conversing raises the driver's alertness. While using HFT may pose some distraction, the crash odds are not significantly different from simply driving. The study concludes that increased crash risk comes primarily from visual, rather than cognitive, distractions (Dingus).

Voice-to-text (V2T) technology is showing promising signs

Already, Ford Motor Company (Ford) has utilized Voice Activated Technology (VAT) to perform certain tasks and reduce visual distractions. In 2007, Ford and Microsoft debuted their infotainment system, "Ford SYNC", which performed many tasks via the driver's voice. Ford SYNC, later called MyFord Touch, demonstrates how VAT can successfully perform driver tasks.

Ford SYNC is an intuitive infotainment system that completes driver tasks using VAT and touch screens. With SYNC, users can perform tasks through their voice, rather than hand held devices. SYNC seamlessly combines the utility of navigation, mobile communicating, and audio devices. Drivers can access these features while driving through voice commands and touch screens.

Before bringing SYNC to market, Ford conducted tests using driving simulators, test tracks, and on-road studies to create a system that reduced visual distractions. By equipping participants in their studies with SYNC, Ford compared tasks completed using VAT against hand-held methods. From their findings, Ford concluded that VAT can minimize eye-off-road time much better than handhelds for tasks such as selecting music reviewing texts, as seen in Figure 3.2 (Shutko).

Figure 3.2 Color-Coded Summary of Handheld (Hh) Tasks Versus Hands-Free (Hf) Tasks

Task	Total Task Time	Total Eyes-Off-Road Time	Standard Deviation of Lane Position	Percentage of Trials With a Lane Exceedance	Maximum Speed Difference	Pedestrian Detection Task Reaction Time
Song	V	V	V	V	V	
Artist	V	V	V	V	V	V
Phone book	V	V	V	V	V	
Incoming call	V	M				
Digit dial	M		V			V
Text review		V	V			V

Note: Green = HF better than HH; yellow = HH better than HF; white = no difference found at .05 alpha level. V indicates that performance using voice command was significantly better than that for visual-manual interaction. M indicates that performance using the visual-manual interface was significantly better than that for the voice interface.

Source: Ford's Approach to Managing Driver Attention

SYNC does not have complete V2T technology currently, but it proves it is possible to implement V2T technologies in vehicles. Many of these short voice tasks such as selecting music and dialing numbers are similar the brevity of text messages. This similarity between tasks implies V2T systems may be a viable alternative to reduce TWD.

V2T within vehicles is still relatively new, and is continuously being perfected before expanding the technology for other tasks. V2T may not be perfect yet, but the Virginia Tech Transportation Institute (VTTI) conducted a study that showed the benefits of V2T within vehicles.

The 2011 study compared driver performance with no task (baseline), hand-held texting, and V2T. Participants of different ages drove vehicles with sensors and cameras that monitored their behavior on a closed course. On the course, drivers created texts of varying length that were requested randomly. After the tests were completed, researchers analyzed text accuracy, driver speed (longitudinal measures), lane deviation (lateral measures), eyes-off-road time (EORT), and subjective ratings from drivers (mental demand, frustration level, and situational awareness).

As expected, the V2T methods were much superior to manual texting, and much closer to the baseline measures. With V2T, there was no significant difference in lane deviation from the baseline measures. This is especially important, as lane deviation is a "well-recognized safety surrogate and should receive greater emphasis…when considering safety implications". For visual distractions, eye glances were significantly lower with V2T (170 versus 3,453). Also with V2T, the researchers never observed an eye glance longer than two seconds, which is the threshold where crash risk dramatically increases. After completing the driving tasks, drivers believed the mental demand to be much lower with V2T, which may mean the cognitive distraction was relatively low. Finally, given only brief instructions, participants across all age

groups performed well and similarly with V2T. Contrasting this to driver performance with hand-helds, older drivers had much less accuracy than younger drivers (82% versus 96%). This is especially telling, as V2T systems have appeal across drivers of all ages (Hankey).

The implication of V2T being implemented is that drivers will be compensating this safety feature by TWD more, thus offsetting any decrease in overall risk. Estimates of how many people engage in TWD currently range from 20-30 percent, which may be depressed due to SDB. It is likely TWD levels will increase with a safer product, based on the risk compensation theory. While TWD levels may increase, V2T systems are quantitatively much safer. In a previous VTTI study, the institute found that manual TWD increases collision risk by 23 times (Richtel). Conversely, the previous naturalistic studies observed collision risk to be closer to one, essentially eliminating a majority of the risk (Shutko). This large difference in crash probabilities may be able to keep aggregate risk low as more drivers start using V2T systems.

The VTTI study on V2T does show promise, but the technology can only be successful if it is proven and there is demand for it. Consumers' favorability towards voice dictation and business activity around speech software will make this very viable.

The external environment will foster the implementation of V2T technology

Studies that examined V2T have implied this market will include a large number of participants. In the previously mentioned VTTI study, 83% of the participants expressed interest in possessing the V2T technology (Hankey). Additionally, Vlingo and Ford found 67 percent of drivers would prefer V2T over hand-held texting (*Texting While Driving in America*, Ford Motor Company).

Consumers have confirmed their interest through purchases of V2T mobile apps. According to Text'nDrive, a voice texting app, the software was the thirteenth most downloaded

mobile app on the Apple App Store. The mobile app has garnered over one million downloads as of 2011 (Text'nDrive).

While product reviews for Text'nDrive are mixed, there are numerous companies trying to capture the increasing demand (Apple, Inc). This competition between V2T companies will drive perpetual improvements and likely make it suitable for the driving environment.

Text'nDrive faces stiff competition from large companies such as Google, Bing, Apple, and Nuance, a voice dictation conglomerate. Additionally, many independent companies are hoping their software will have the ability to compete with these larger companies. New V2T software from Vlingo, Drivsafe.ly, and Jibbigo Voice Translation are working to improve the quality of V2T technology (Cassavoy).

While large corporations and startups are competing to provide superior technology, several smaller companies are being acquired to spearhead innovations. The acquisitions are combining the cash flows of large corporations and ingenuity of startups to create superior products. At the end of 2011, Nuance acquired startup Vlingo in order to compete with Apple's Siri, further intensifying competition in the V2T market (Wauters). On the other spectrum, Amazon recently purchased Text-to-Voice (T2V) company Ivona Software to increase its dominance (Chaudhur). Furthermore, automakers such as General Motors Company and Ford are opening up their in-vehicle-infotainment (IVI) systems to developers to spur vehicle connectivity capabilities (Newcomb). The increasing companies and competition surrounding V2T software indicate the technology will continuously improve to make this technology viable.

The driver behind the V2T business expansion is consumer demand for these products. Drivers are now starting to understand the dangers of TWD and consequentially purchasing available V2T products. Their demand for and frustrations with preliminary software has

prompted many companies to invest in this software. The dynamics of both consumers and producers will likely result in superior V2T technology that can handle the challenges of TWD.

Policymakers must work with automakers to create effective legislation

With many companies working to capitalize on the V2T market, policymakers should focus their resources to write requirements for vehicle use. Instead of keeping research internal with NHTSA, policymakers need to consult the Alliance of Automobile Manufacturers (AAM) to produce the concise guidelines that will allow effective development of V2T technology.

The AAM is a trade group comprising of 12 automotive OEMs whose vision is "A united industry committed to enriching society through sustainable mobility" ("About the Alliance"). As such, the AAM extensively researched how to integrate IVI into vehicles while keeping drivers safe. By 2003, members of the AAM had voluntarily agreed to a preliminary set of IVI design guidelines. And by 2013, the AAM was on its third iteration of IVI guidelines and has it divided into 24 different focus principles to ensure driver safety (*The Alliance's Driver Focus Guidelines*). By collaborating research with the AAM, both parties can work together to develop V2T guidelines that provides the greatest benefit to society, and better understand the conditions of TWD.

Contrary to previous beliefs, visual distractions are the main cause of vehicular accidents, and HFT can still be used safely. The public is embracing V2T technology and companies are racing to provide the best possible service for TWD. V2T has been proven to not be significantly more distracting than driving alone, so the next step for policymakers is to work with automakers to create the most comprehensive guidelines that make V2T for TWD safe. By pursuing V2T rather than TWD bans, policymakers may be able to finally manage this predicament before it gets out of control.

Conclusion

A proposed idea is only as good as its embracement. Policymakers need to realize humans are not easily manipulated beings, especially in the case of TWD. In this situation, there are many more factors than are currently being considered. By using legislation to control TWD levels, policymakers are betting small monetary disincentives can control numerous human behaviors.

The embracement of TWD bans has not been felt. Policymakers are divided on it, police departments cannot enforce it, and drivers are working around it. Without adoption across all parties, TWD bans hold no more weight than the paper they are printed on.

To find the right outcome, policymakers need examine the situation from every direction. Can police forces actually enforce bans? Can fear messages work? Why do people insist on TWD? Are these surveys correct? And most importantly, do these results replicate in the real world? By taking a holistic approach, policymakers will find answers to questions they did not previously ask, thus increasing the knowledge of the situation.

By taking a comprehensive approach, the findings lead to V2T technology currently being the most viable plan. This is a safe plan that will be supported by drivers, and is likely replicable in the real world. That being said, more research needs to be conducted to understand how to safely introduce this into today's vehicle. While this is relatively new, V2T shows promising results and is a step in the right direction.

The most efficient way to make V2T a reality is to have all parties work together. NHTSA, AAM, and IIHS all have conducted tremendous research in the area. The only way to extract any knowledge from this data would be to combine efforts, like this paper has. By doing

so, the entirety of the TWD situation becomes much clearer. By pooling resources together, the parties can ultimately learn how to integrate V2T in passenger vehicles.

Thus, policymakers need to realize that this is not an "Us vs. Them" situation. Roads safe from TWD distractions are a universal desire. Policymakers want it, insurance companies want it, automakers want it, and lastly, society wants it. While it may be contradictory to what policymakers believe, comprehensive research shows TWD bans are inefficient, and V2T can alleviate the situation. By ignoring the possibility of V2T, policymakers are foregoing a likely alternative that can better manage the outcomes of the TWD predicament.

Appendix

Texting laws by state

State	Text Messaging Ban			Crash Data
	All Drivers	School Bus Drivers	Novice Drivers	
Alabama	Yes (Primary)	Covered under all driver ban		
Alaska	Yes (Primary)	Covered under all driver ban		Yes
Arizona				
Arkansas [1]	Yes (Primary)	Covered under all driver ban		Yes
California	Yes (Primary)	Covered under all driver ban		Yes
Colorado	Yes (Primary)	Covered under all driver ban		Yes
Connecticut	Yes (Primary)	Covered under all driver ban		
Delaware	Yes (Primary)	Covered under all driver ban		Yes
D.C.	Yes (Primary)	Covered under all driver ban		Yes
Florida				Yes
Georgia	Yes (Primary)	Covered under all driver ban		Yes
Guam	Yes (Primary)	Covered under all driver ban		
Hawaii [2]				
Idaho [3]	Yes (Primary)	Covered under all driver ban		See footnote
Illinois [4]	Yes (Primary)	Covered under all driver ban		Yes
Indiana	Yes (Primary)	Covered under all driver ban		Yes
Iowa	Yes (Secondary)	Covered under all driver ban		Yes
Kansas	Yes (Primary)	Covered under all driver ban		Yes
Kentucky	Yes (Primary)	Covered under all driver ban		
Louisiana	Yes (Primary)	Covered under all driver ban		Yes
Maine	Yes (Primary)	Covered under all driver ban		Yes
Maryland	Yes (Primary)	Covered under all driver ban		Yes
Massachusetts	Yes (Primary)	Covered under all driver ban		Yes
Michigan	Yes (Primary)	Covered under all driver ban		Yes
Minnesota	Yes (Primary)	Covered under all driver ban		Yes
Mississippi		Yes (Primary)	Learner or Provisional License (Primary)	
Missouri			≤21 (Primary)	
Montana				Yes
Nebraska	Yes (Secondary)	Covered under all driver ban		Yes
Nevada	Yes (Primary)	Covered under all driver ban		Yes
New Hampshire [5]	Yes (Primary)	Covered under all driver ban		
New Jersey	Yes (Primary)	Covered under all driver ban		Yes
New Mexico			Learner or Provisional License (Primary)	Yes

New York	Yes (Primary)	Covered under all driver ban		Yes
North Carolina	Yes (Primary)	Covered under all driver ban		
North Dakota	Yes (Primary)	Covered under all driver ban		Yes
Ohio	Yes (Secondary)	Covered under all driver ban		
Oklahoma		Yes (Primary)	Learner or Intermediate License (Primary)	Yes
Oregon	Yes (Primary)	Covered under all driver ban		Yes
Pennsylvania	Yes (Primary)	Covered under all driver ban		Yes
Puerto Rico	Yes (Primary)	Covered under all driver ban		
Rhode Island	Yes (Primary)	Covered under all driver ban		Yes
South Carolina[6]				See footnote
South Dakota				Yes
Tennessee	Yes (Primary)	Covered under all driver ban		Yes
Texas [7]		Yes, w/ passenger≤17 (Primary)	Intermediate License, 1st 12 mos. (Primary)	Yes
Utah [8]	Yes (Primary)	Covered under all driver ban		Yes
Vermont	Yes (Primary)	Covered under all driver ban		
Virgin Islands	Yes	Covered under all driver ban		Yes
Virginia	Yes (Secondary)	Covered under all driver ban (Primary)	Covered under all driver ban	Yes
Washington	Yes (Primary)	Covered under all driver ban		Yes
West Virginia	Yes (Primary)	Covered under all driver ban		
Wisconsin	Yes (Primary)	Covered under all driver ban		
Wyoming	Yes (Primary)	Covered under all driver ban		Yes
Total States	**39 + D.C., PR, Guam, Virgin Islands Primary (35 + D.C., PR, Guam) Secondary (4)**	**3** (All Primary)	**5** (All Primary)	**35 + D.C., Virgin Islands**

[1] Arkansas also bans the use of handheld cell phones while driving in a school zone or in a highway construction zone. This law is secondarily enforced.

[2] Hawaii does not have a state law banning the use of handheld cell phones. However, all of the state's counties have enacted distracted driving ordinances.

[3] Idaho has a "Distraction in/on Vehicle (List)" attribute as part of its Contributing Circumstances element, and officers are supposed to list the distractions in the narrative.

[4] Illinois bans the use of handheld cell phones while driving in a school zone or in a highway construction zone.

[5] Dealt with as a distracted driving issue; New Hampshire enacted a comprehensive distracted driving law.

[6] South Carolina has a Distracted/inattention attribute under Contributing Factors.

[7] Texas has banned the use of hand-held phones and texting in school zones.

[8] Utah's law defines careless driving as committing a moving violation (other than speeding) while distracted by use of a handheld cellphone or other activities not related to driving.

Source: GHSA

Findings from NHTSA High-Visibility-Enforcement pilot program

Figure 1
Demonstration Program and Evaluation Timeline in Harford, CT & Syracuse, NY

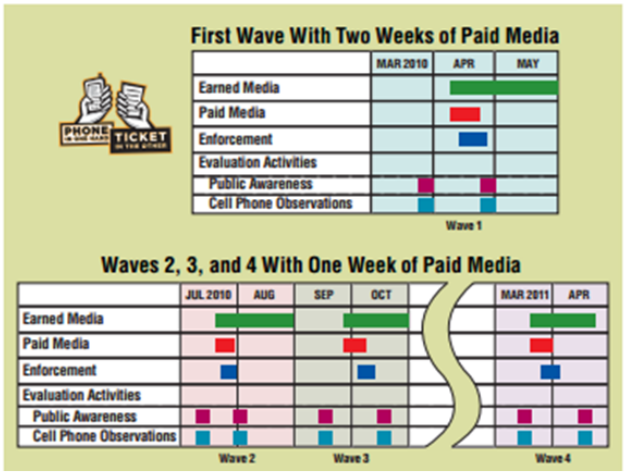


Table 1
Media Buy

	Wave 1 (2 weeks)		Wave 2 (1 week)		Wave 3 (1 week)		Wave 4 (1 week)		
	Hartford	Syracuse	Hartford	Syracuse	Hartford	Syracuse	Hartford	Syracuse	Total
TV Cost	$108,651	$36,898	$57,098	$21,517	$70,244	$21,607	$68,727	$32,249	$416,991
Radio Cost	$27,204	$12,338	$17,586	$9,431	$14,628	$5,198	$15,954	$8,282	$110,621
Online Cost	$4,624	$4,425	$3,750	$3,750	$2,500	$2,500	$5,000	$5,000	$31,549
Total Cost	$140,479	$53,661	$78,434	$34,698	$87,372	$29,305	$89,681	$45,531	$559,161

Table 2
Enforcement Hours and Citations Issued

	Wave 1		Wave 2		Wave 3		Wave 4		Average per wave	
	Hartford	Syracuse	Hartford	Syracuse	Hartford	Syracuse	Hartford	Syracuse	Hartford	Syracuse
Dedicated Hours	1,345	1,370	1,345	1,337	1,045	1,345	1,272	1,307	1,252	1,340
Hand-Held Phone Use	2,229	2,185	2,327	1,977	2,257	2,341	2,621	2,354	2,359	2,214
Text/E-mail/ Distraction	24	115	21	169	64	183	115	263	56	183
Citations/ 10k Population	97	167	100	156	99	183	117	190	103	174

Figure 13
Connecticut: Percent of Drivers Observed Manipulating Hand-Held Phone

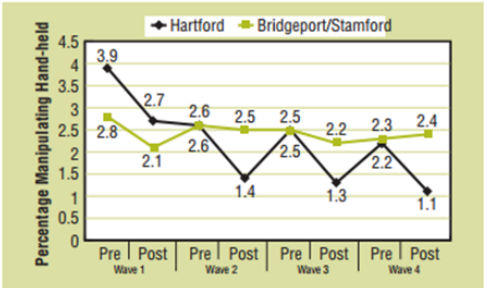
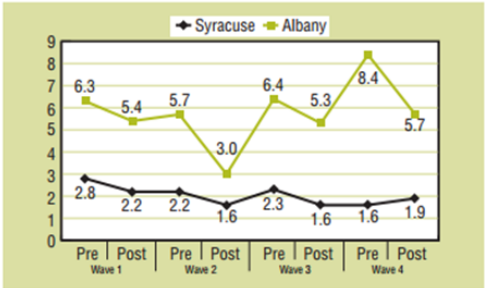


Figure 16
New York: Percent of Drivers Observed Manipulating Hand-Held Phone



Source: NHTSA

Acronyms

AAM	Alliance of Automobile Manufacturers
ADAS	Advanced Driver Assist Systems
COPS	Community Oriented Policing Services
FCC	Federal Communications Commission
GHSA	Governor's Highway Safety Association
HFT	Hands-Free Technology
HLDI	Highway Loss Data Institute
HVE	High-Visibility-Enforcement
IIHS	Institute Insurance Institute for Highway Safety
IVI	In-Vehicle-Infotainment
LWE	Lake Wobegon Effect
MADD	Mothers Against Drunk Driving
MOU	Minute of Use
NHTSA	National Highway Traffic Safety Administration
NSC	National Safety Council
NTSB	National Transportation Safety Board
PERF	Police Executive Research Forum
SDB	Social Desirability Bias
SUV	Sport Utility Vehicle
TBV	Truck Based Vehicle
T2V	Text to Voice
TBV	Truck Based Vehicle
TWD	Texting While Driving
V2T	Voice to Text
VAT	Voice Activated Technology
VTTI	Virginia Tech Transportation Institute

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