CHAPTER 3. AGGRESSIVE DRIVING AND SPEEDING

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ABSTRACT

Purpose: This chapter synthesizes a variety of findings on the topic of aggressive driving, and delivers a suite of strategies for moderating such behaviors. Examples and formal definition of aggressive driving acts are given, along with specific techniques for reducing excessive speed and other aggressive behaviors.

Methodology: Key references from the literature are summarized and discussed, and two examples detailing how multi-parameter distributions and models compare with the negative binomial distribution and model are presented.

Findings: Speeding is the most common type of aggressive driving and speeding-related crashes represent a high share of traffic deaths. Speeding relates to many factors, including public attitudes, personal behaviors, vehicle performance capabilities, roadway design attributes, laws, and policies. Anonymity, while encased in a vehicle, and driver frustration, due to roadway congestion or other issues, contribute to aggressive driving.

Research implications: More observational data are needed to quantify the effects of the contributing factors on aggressive driving.

Practical implications: Driver frustration, intoxication, and stress can lead to serious crashes and other traffic problems. They can be addressed, to some extent, through practical enforcement, design decisions, and education campaigns.

Key words: Aggressive driving, speeding, traffic law enforcement, roadway safety

BACKGROUND

Among the many driver errors that are typically at play in pre-crash contexts, aggressive driving is a serious issue, accounting for nearly 7 million crashes every year in the U.S. alone (National Highway Traffic Safety Administration 2014) and over half of all U.S. fatal crashes (AAA Foundation for Traffic Safety 2009). Aggressive driving is believed to have been rising in response to rising traffic congestion, which frustrates many drivers (Neuman et al. 2003). Rising congestion is largely due to more motorists driving more miles every year, with increases in vehicle-miles traveled (VMT) outstripping new roadway lane-mile provision by one to two orders of magnitude (NHTSA 2000). At the same time, the level of law enforcement present on major roadways and elsewhere in the system may be falling, due to shifting police priorities. Importantly, many locations find positive correlations in crash counts, congestion, and aggressive driving, so better enforcement of aggressive driving may ameliorate many roadway issues at once (NHTSA 2000). Among the many aggressive behaviors drivers can demonstrate, excessive speed, a topic emphasized in this chapter, is the most common (AAAF 2009). A suite of strategies for combatting aggressive behaviors are discussed towards the end of this chapter.

What is Aggressive Driving?

Aggressive driving is not easy to define. Most national policies and definitions generally exclude violent, "road rage" situations, where intent is to harm, and criminal statutes can be

invoked (Tasca 2000). Aggressive driving behaviors (sometimes classified as risky or dangerous driving behavior [Richer and Bergeron 2012, Richard et al. 2012]) are labeled as traffic offences, rather than criminal offences, and include excessive speed, failure to signal a lane change, running a red light or a stop sign or railroad signal, failure to yield at a yield sign, passing another on the outer lane side (depending on whether cars drive on the right or left in particular countries), tailgating, weaving in and out of traffic and other unsafe lane changes, passing on the shoulder, prevention of others' passing, yelling or gesturing, sustained horn honking, headlight flashing, and other "(d)isplays of annoyance or hostility" (Tasca 2000, p. 2). Such behaviors are often provoked by travel delays, due to unexpected traffic obstructions and/or poorly coordinated signals. Mina et al.'s (2014) study of Indian drivers found that police presence is a strong moderating factor, curbing anger and driver aggression.

As Tasca (2000, p. 2) notes, many drivers admit to exhibiting such behaviors from time to time. Great Britain's Automobile Association's 1995 survey of 526 drivers (Joint 1997) found that 62 percent reported having engaged in aggressive tailgating over the prior year, 59 percent had engaged in "high beaming" those they wished to pass, 48 percent had received rude or obscene gestures from other motorists, 21 percent had been "deliberately blocked by another vehicle", and 21 percent had received some verbal abuse while motoring (Weisenthal et al. 2016). A more recent AAAF (2008) survey found that 78 percent of Americans considered aggressive driving to be a serious problem, yet nearly half reported driving at least 15 mi/h over the speed limit in the past month. Such responses underscore the notion that many drivers do not have the same high standards for their own driving as they do for others with whom they share the roadways, and/or they over-estimate their abilities as managing risks.

Tasca's (2000, p 2) extensive research led him to recommend the following definition: "A driving behaviour is aggressive if it is deliberate, likely to increase the risk of collision and is motivated by impatience, annoyance, hostility and/or an attempt to save time." In contrast, the NHTSA (2015) defines aggressive driving as when "an individual commits a combination of moving traffic offenses so as to endanger other persons or property." Weisenthal et al. (2016) propose a definition based on a driver's actions, rather than intent since motivation is so difficult to measure and establish in practice. (As Richer and Bergeron [2012] note, intentionally aggressive driving, versus risky, dangerous driving practices can emanate from very different personality profiles.) And some communities have defined aggressive driving as "three or more moving violations as part of a single continuous sequence of driving acts, which is likely to endanger any person or property" (NHTSA 2000, p. 6).

Who Drives Aggressively Most Often?

NHTSA (2000) notes that aggressive driving deserves the kind of attention that impaired or DUI driving received decades ago, to ensure that aggressive driving is not "socially acceptable". Tasca's (2000, p. 3) review of self-reported survey-based literature suggests a greater likelihood of aggressive driving behaviors in those that are young, male, "in traffic situations which confer anonymity and/or where escape is highly likely" (e.g., at night or along a freeway), already angry (often due to other, non-traffic events), "believe they possess superior driving skills", "generally disposed to sensation-seeking or aggressiveness in other situations", and/or facing unexpected traffic congestion. Similarly, Ellison-Potter et al. (2001) finds that aggressive driving is more often associated with contextual or situational variables (like sensing one's relative anonymity on a busy freeway and events that stimulate driver aggression) than with a driver's general

disposition. Events that trigger aggression often occur on the roadway itself, like feeling another driver has cut one off; such situations can result in retaliatory actions (Weisenthal et al. 2016).

Shinar (1998) notes that more extroverted, "Type A" personalities tend to have lower thresholds for tolerating frustration and, therefore, are more likely to demonstrate aggressive driving behaviors. Those driving in settings where negative consequences are less likely (e.g., contexts offering greater driver anonymity and escape) and those sensing that others are driving improperly (e.g., traveling relatively slowly in the left-most lane of a multilane, divided highway or waiting too long to accept a gap in traffic and leave the stop bar) are more likely to demonstrate aggression. Shinar (1998) distinguished aggressive drivers (which is a long-lived and relatively infrequent, but intrinsic disposition) from aggressive driving (which is more frequent, but abates when the annoyance or frustration is removed). Exceeding the speed limit may or may not be considered aggressive: if done in the presence of other motorists so the safety of others is at risk by not driving faster; it is generally considered aggressive, even if the speeder is, for example, simply trying to avoid being late for an important meeting (Tasca 2000).

THE ROLE OF SPEEDING

As noted above, many behaviors constitute aggressive driving. Speeding is a common, costly, and relatively aggressive behavior for many drivers. In fact, speeding was a causal factor in over 30 percent of 2010 U.S. motor vehicle fatalities and resulted in more than 10,000 deaths, nearly $60 billion in economic costs, and $210 billion overall societal harm (FARS 2012, Blincoe et al. 2014). Speeding is aggressive when a driver significantly and dangerously exceeds the speed of those around him/her.

Speeding contributes to both the frequency and severity of traffic crashes (Kockelman et al. 2006). It impairs a driver's ability to react to emergencies, like sudden tire blowouts, unsafe maneuvers by other travelers, roadway hazards, and dangerous weather conditions. Speeders need additional time and distance to slow and stop their vehicles, and can create fear and confusion for those around them – including pedestrians and cyclists.

Perhaps most importantly, the laws of physics (kinetic energy = 0.5 × mass × velocity^2) suggest that speed is one of the most critical factors affecting crash severity (TRB, 1998). This is a key basis for the idea that "Speed Kills", and the notion that a speed limit increase will naturally lead to higher numbers of traffic fatalities and serious injuries. In some contrast, Lave (1985) argued for a "Variance Kills" theory, as first proposed by Solomon (1964) and supported by Cerillo (1968). The rural road data analyzed by these researchers appear to indicate that crash likelihood increases with an individual's deviation from that roadway's average speed. Several researchers (Fowles and Loeb 1989; Levy and Asch 1989; and Snyder 1989) have attempted to refute Lave's argument by enhancing his data and model specification. Interestingly, as Lave (1989) notes in his reply/rebuttal, their findings provide evidence for both theories (both speed and its variance are dangerous). Somewhat later, Davis (2002) noted how various correlations in aggregate data of speed variations and crash rates could be simply an ecological fallacy.

Evans (2004) reports how data from Australia and Sweden show sizable crash rate increases with speed, via the following (approximate) relationship:

$$\frac{CR'}{CR^0} \approx \left(\frac{V'_{50\%}}{V^0_{50\%}}\right)^p$$

where the exponent p is roughly 4 for fatal crash rates and 2 for all crash types, CR denotes crash rates (after and before the change in speeds), and $V_{50\%}$ denotes the median (50^{th} percentile) speeds of the traffic (after and before speed changes).

This relationship suggests that just a 1-percent increase in speed (so $V'/V^0 = 1.01$) will result in a 4-percent higher fatal crash rate. In terms of an occupant's own risk, Evans reports that research estimates the probability of not surviving the crash goes up 4 to 12 percent. If speeds fall just 3 percent, Evans (2004) expects a 13 percent reduction in one's probability of dying, which is similar to the benefits provided by airbag use. Such results may change quite a bit with the advent of smarter, more automated, connected, and (eventually) self-driving vehicles.

Kockelman et al.'s (2006) National Cooperative Highway Research Program report traced the many separate and inter-related effects of speed limit increases in the U.S. on: (1) driver speed choice, (2) roadway crash rates (per mile-traveled on that road), and (3) injury severity outcomes for those crashes. Their data suggest that crash rates increase only slightly with a speed limit increase, but added that injury severities are notable, as indicated in Table 1. While higher speeds are more dangerous, everything else constant - due to the kinetic energy at play, a 2005 NHTSA study found that around half of all fatal speeding crashes in the U.S. occur on roads with a posted speed limit of 50 mph or lower (Liu et al. 2005). Malyshkina and Mannering's (2008) look at the state of Indiana's crash rates and severities after speed limits went up in 2005, found more severe crashes along non-interstates, but no statistically significant changes along interstate highways in that state at that time.

Table 1. Safety Effects Associated with a 10 mi/h Speed Limit Increase on High Speed Roads (Source: Kockelman et al., 2006)

Increase in Speed Limit (mi/h)	Change in Average Driving Speed (mi/h)	Average Change in Total Crash Count	Change in Probability of Fatal Injury	Total Change in Predicted Fatal Injury Count
55 to 65	+3	+3.3%	+24%	+28%
65 to 75	+3	+0.64%	+12%	+13%

Note: Results come from typical high-speed roadway settings.

Speeding's Ties to Demographic Attributes and Driving Contexts

As alluded to above, observable driver characteristics are often correlated with aggressive behaviors. Context is also important. For example, Evans (2004) suggested that February is the month with the least severe crashes (measured as fatalities per injury) because of its more difficult driving conditions (due to the presence of snow, ice, and storms in many parts of the U.S.), resulting in lower speeds. While young males tend to have the best reaction times, visual acuity, and a relatively high knowledge about vehicles and driving, they also exhibit a higher crash rate because they tend to take more risks (Evans 2004). As evident in many studies, Schroder et al. (2013) also found that young drivers tend to speed more frequently, and speeding tends to be less likely as one ages. Inexperience is a serious issue, and graduated licensing strategies (now the norm across the U.S.) certainly help reduce such risk-taking and presumably more aggressive behaviors among younger drivers (see Chapter 2). Road rage (defined by NHTSA as a "physical assault of a person or vehicle as a result of a traffic incident") involves using a vehicle as one's weapon and appears to be most common among relatively young males (ASC 2015).

Richard et al. (2012) analyzed driver speeding behavior using naturalistic driving data (with cameras watching many drivers, and their traffic conditions, over a number of months, in the U.S.), as well as data from focus groups. They noticed that speeding is relatively common among drivers, and that young male drivers are more likely to speed than other demographic groups studied. They also concluded that speeding is not just associated with a small group defined by age (i.e., young), gender (i.e., male), and/or attitude (i.e., recklessness or risk-taking propensity). Most people admitted that they sped at least some of the time, but they normally did not think they were driving unsafely when they sped. Speeding behavior is strongly related with a number of factors, like situational factors (e.g., type and length of trip, presence of others in the vehicle, likelihood of limit enforcement, opportunities to speed, road conditions, and geographic location), demographic factors, and a driver's "personality" (including a person's motivations, beliefs, and attitudes toward speeding). They found that personality factors were generally stronger predictors of speeding tendencies than demographic attributes, and speeding was more common during the morning peak period (or "rush hour"), as well as on weekends.

Rural driving also comes with higher speeds, thanks to less congestion and less complex navigation, resulting in significantly higher fatality rates (Evans 2004, Kockelman et al. 2006, Levine et al. 1995a, 1995b). Evans (2004) believes that road improvements tend to result in higher speeds and less congestion, and thus often noticeably higher fatality rates, but higher-design roadways tend to be safer, per mile traveled (Kockelman et al. 2006), and actual speed effects are tricky to ascertain exactly, because actual vehicle speed is generally unknown at the time of crash (Levine et al. 1995c).

Evans (2004) argues that speedometers are very important in helping cue drivers to their actual speed, helping them avoid failures in speed judgment. Of course, speed limiters and GPS-based warnings of one's location-based speed-limit violations will be useful. Many people wonder why vehicles are designed and sold to go well over 100 mi/h, if 100 mi/hr is already well above legal speed limits in nearly every nation. Speed governors (common on fleet-managed trucks and lorries) and automated speed enforcement strategies (along roadways) seem wise, but are often unpopular with the motoring public, when applied to their own personal vehicles.

Chen and Kockelman's (2013) survey of over 1,000 Americans found that the least popular crash-reduction measures lie in addressing speeding violations: only 40.5 percent of respondents admitted to regularly driving above the speed limit on freeways, but over half (54.3 percent) responded that they support automated speed enforcement (ASE) technologies (while 27.3 percent opposed such enforcement). Among ASE supporters, 10 mi/h was the average speed over the speed limit for which automatic ticketing would be acceptable, and this jumped to 15 mph for those who opposed ASE. Use of speed governors or limiters on all vehicles was the least popular policy, with 37 percent approving and 41 percent opposing. Those who support governors supported an average maximum speed of 83 mi/h, and opponents favored 106 mi/h.

As Chen and Kockelman (2013) note, despite the overall negative view of such speed reduction measures, ASE cameras and on-vehicle speed governors have been shown to reduce injury crashes by 11 to 58 percent and 8 to 34 percent, respectively. Saving lives and property can make terrific economic and social sense even when individuals are reluctant to espouse such changes in current laws and vehicle designs. But the debate may be moot, as highly automated and self-driving vehicles begin production: such vehicles may be designed, by law, to obey speed limits and other traffic rules.

The Role of Gender

Evans (2004, p. 212) believes that the fastest drivers on a road are to blame for most fatal crashes, and make the "main contribution to risk". He provides tales of speed violation rates across U.S. drivers' ages, genders, and ethnicities, using 1998 data; and these suggest that men were receiving tickets for speeding twice as often as women were. But, as Kweon and Kockelman (2003) note, men tend to drive almost 50 percent longer (total) distances than women do. And they may drive more often in settings that lead to higher police observation (e.g., during the night and along high-speed facilities). Evans (2004) wrote that younger drivers (ages 16 to 22) received the most violations (per year of driving) among the 3 age groups (young, middle-age, and older), even though they drive significantly less distance, per year, than older persons do (Kweon and Kockelman 2003). Kweon and Kockelman (2006) analyzed the U.S. Motor Vehicle Occupant Safety Surveys to estimate that males, college-educated and higher income individuals tend to travel at higher speeds on highways, and are more likely to drink and drive (or at least admit to it), those of higher income and education are also more likely to wear seat belts, everything else constant. Levine (2011) examined the Houston metro area's 25,240 crashes (between 1991 and 2001) and found that more males exhibit riskier driving behavior than females. He also noticed that males are more likely to have crashes in the central city, which tends to have higher crash rates per VMT, as compared to other parts of the region. Moreover, NHTSA's safety statistics and survey results consistently show males drivers more likely to speed and more involved in fatal crashes while intoxicated than women drivers (see, e.g., Schroeder et al. 2013 and NHTSA 2008). Figure 1 illustrates such findings.

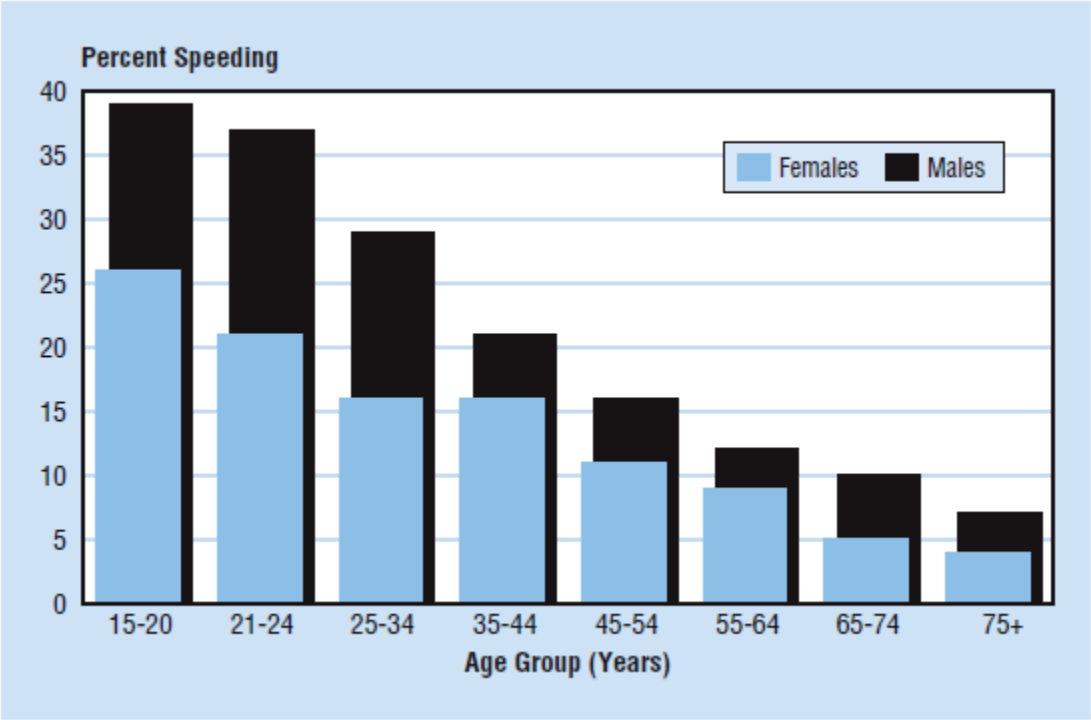

Figure 1. Speeding Drivers in Fatal Crashes by Age and Gender, 2006 US Data (Source: NHTSA 2008)

Evans (2004) noted that a Scottish investigation reported males being more likely to slow down in light rain, versus female drivers, and that risk-taking or aggressive-driving behaviors (such as

higher speed choices, tailgating vehicles in front, driving unbelted, and running red lights) tend to fall with a driver's age. According to Evans, earlier research had suggested that those dying in crashes or receiving more driving violations are much more likely to be in legal troubles and/or have personality disorders, be less academically successful, and more antisocial. They also tend to more often have poor credit histories, smoke cigarettes, and so forth. Evans (2004, p. 224) wrote that "Cars are used as an outlet for the independence, rebelliousness, and peer acceptance needs of newly licensed adolescents." He also noted that some past studies find higher crash rates and ticketing rates among children of parents with such issues.

Evans (2004) observed that males' testosterone levels peak quite abruptly around age 20 and then decline, much like severe crash rates and arrests (per capita) do, when plotted versus a person's age. If one plots the male-to-female ratios, these follow a very similar profile, rising to roughly 4 to 1 on all three indicators (average testosterone levels, crash rates, and arrests per capita) at around age 20[1]. Such similarities may suggest that testosterone is a "common origin" of such problematic and dangerous behaviors, but Kweon and Kockelman's (2006) work found the same crash rates for males and females, across different age groups. Moreover, females are more likely to die in the same crash (see, e.g., Wang and Kockelman 2005, Kockelman et al. 2006, Kahane, 2013), everything else constant (including seating position in the vehicle), thus women may be at more risk per mile driving.

Driving Under the Influence

Driving under the influence (DUI) is also considered aggressive driving. NHTSA (2013) notes that about 31 percent of all U.S. motor vehicle traffic fatalities involve alcohol-impaired driving. Evans (2004) notes that people with higher blood-alcohol-content (BAC) levels are more likely to die when involved in a crash: for example, those with BAC of 0.08 percent (i.e., 8 grams of alcohol per 100 mL of blood) are estimated to be 73 percent more likely to die than those with 0 percent BAC, in the same crash, largely because the crashes that result under DUI conditions are less controlled (e.g., at higher speed and later at night, with less thoughtful driver response). In 2012, 7 percent of drivers with a BAC of .08 percent or higher involved in fatal crashes had a prior conviction for DUI; only 1 percent of drivers in fatal crashes with no alcohol had a prior conviction for DWI (NHTSA, 2013). Drunk drivers often experience impaired perceptions that may result in risky behavior such as speeding (Syrcle and White, 2006). According to NHTSA (2010a), drivers with 0.08 percent or higher BAC in fatal crashes tend to have more prior driving convictions (e.g., speeding) than drivers with lesser or no alcohol content. DUI behavior often correlates with aggressive driving behaviors.

OPPORTUNITIES FOR MODERATING AGGRESSIVE DRIVING AND MANAGING SPEED

Unfortunately, aggressive driving is associated with higher rates of crash involvement and is a factor in a high share of recorded crashes (Blows et al. 2005, Mann et al. 2007, Wells-Parker et al. 2002, AAAF 2009). Moderating aggressive driving requires a multi-prong approach, including driver education, engineering via roadway design details, laws, and enforcement (Neuman et al. 2003).

[1] After age 50, testosterone ratios in males vs females rise to roughly 8 to 1, but absolute testosterone levels are down, and crash rate and arrest ratios are much less than 8 to 1 for males vs females in that age group.

Speed limits are standard practice around the globe, and they can be made variable (to reflect changing weather and traffic conditions, in real time, for example) in coming years, thanks to greater use of connected/communicating vehicles and relatively precise location information provided via global positioning systems (GPS). Variable speed limit strategies have been widely used in some European countries (Mirshahi et al. 2007) to improve traffic flow and safety, and possibly reduce emissions and conserve fuel. Proper use of the variable speed limit strategy may also improve driver compliance with speed limits, a common form of aggressive driving.

Other countermeasures include higher traffic fines, with mandated reporting of violations to insurance companies and loss of driving licenses, along with roadside units to display vehicle speeds or other poor behaviors, making violations more obvious to drivers. Speed governors for those caught speeding may also prove a useful policy tool to pursue (much like ignition locks on vehicles of those who have been caught driving while intoxicated), but there is no evidence of such strategies yet in place. Roadway design strategies, automated enforcement, and driver education options are covered in more detail below.

Driver Education

"Driver education" encompasses the idea that drivers know the rules of the road, including what constitutes aggressive driving versus appropriate driving behavior, what the speed limits are from location to location, and the risks and consequences of poor driving behaviors. Unfortunately, Sivak et al.'s (2007) review of the literature suggests that standard driver education has not had significant success in taming speeding violations. Perhaps improvements in vehicle safety and performance (in the form of side air bags and electronic stability controls, for example) is making drivers feel safer at higher speeds, thus simply maintaining current speed-violation levels is a measure of success.

More useful training, in the domain of avoiding aggressive driving, may come from finding ways to help drivers recognize that many traffic situations are not intentional, and that any retaliatory actions are offensive. For example, one's being abruptly cut off may be due to another who is new to driving or having to get to the hospital to see a very ill family member, and being slowed in traffic by a lead driver may be due to engine issues, an elderly driver lacking confidence or good nighttime eyesight. In other words, apparently poor driving behaviors do not always constitute bad intent by the drivers of those lead vehicles.

Weisenthal et al. (2016) also recommend training drivers to reduce stress, via breathing exercises en route (or while roadside), carpooling or public transit use, and other helpful practices, both psychological and physical. And they recommend using the media to communicate the downsides of aggressive driving (such as fatal crash details) and possibly using lotteries with incentives to reward those who obey speed limits regularly and such. Finally, simply labeling all cars and trucks, or just those of repeat offenders, with "How's my driving?" stickers, including phone numbers to call for reporting purposes, can pay dividends (by reducing drivers' perception of anonymity on motorways). Smart phone applications can be designed and developed to provide feedback on people's driving behavior, which potentially helps promote safe driving.

Engineering: Roadway and Vehicle Design

Weisenthal et al. (2016) recommend traffic calming techniques for diminution in aggressive driving. Standard treatments are narrower lanes, mid-block chicanes and traffic humps, rumble strips, raised pedestrian platforms, and other obstacles to high-speed driving. All of these can

help, at least in lower-speed locations (like residential streets). Smart et al. (2005) suggest designing vehicles to (temporarily) lower horn volume after repeated horn use, and send audible messages to drivers who are following too closely, for example.

Technologies can also be used to monitor the speed of vehicles and help law enforcement agencies to better deploy their officers to enforce speed limits. For example, connected vehicle technologies allow vehicles to talk to each other and to roadside devices, to relay their positions, to avoid collisions, and to share other valuable information. Connected vehicles can warn drivers of speeders and other problematic driving nearby, and help law enforcement agencies pinpoint areas where vehicle speeds are frequently exceeding speed limits or other laws, and decide where they should step-up patrols to catch violators.

Radar (or Lidar) and cameras and are commonly used to detect and deter speeding and other traffic offenses, such as red light running, illegal rail crossings, and toll violations. Radar or Lidar detectors measure the speed of vehicles, cameras capture images of vehicles speeding and committing other violations, and citations (along with images) are mailed to the vehicle owner. Such automated enforcement technologies have proven effective in ensuring compliance with speed limits and other traffic laws and thus enhancing traffic safety. For example, Friedman et al. (2009) found that speed cameras and reduced speed limits could reduce operating speeds, and thus reduce fatal injuries. Ellison-Potter et al. (2001) suggested that the use of "camera radar" warning signs would reduce anonymity and thus reduce aggressive driving behaviors such as speeding. Automated enforcement does not intend to replace traditional law enforcement officers; instead, it augments enforcement levels at locations where traffic enforcement officers cannot be deployed safely.

Currently, rather few jurisdictions use automated enforcement technologies, like speed cameras, which are limited or prohibited in several U.S. states. To help obtain public support of such policies, automated enforcement can easily be limited to particular neighborhoods, fines can be lower than standard speeding tickets issued directly by police officers, and citations may not show on driving records. In addition, radio and laser detection used by motorists to avoid such detection should be prohibited.

Further Suggestions

In order to address aggressive driving, relevant laws must be on the books and ready to apply. NHTSA (2000, p. 7) stresses the importance of reviewing what statues already exist in city or state, to see if they appropriately address "the problem of careless or negligent driving." Such laws regularly already exist, and rigorous enforcement of such laws then becomes critical. NHTSA (2000) urges that convictions result in significant "point loss" on one's driving record (which affects insurance rates, and may result in compulsory education and training) and/or suspension of one's driving license, with more severe penalties for repeat offenders and those whose actions result in injury to others. NHTSA's also recommends use of the news media (for regular public service announcements and other education campaigns), real-time radar and video (on board enforcement vehicles) to record key evidence and thus facilitate legal prosecution, red-light cameras with automated photos, and red-light indicators (on the back sides of signals) to alert police of conditions just downstream of signal lights (which facilitates safe stopping of red-light violators).

NHTSA notes that special laws may be needed to allow use of unmarked vehicles (including those with cherry-picking lift units, to provide better video of traffic violations in hot-spot

locations). NHTSA (2000) also recommends a single, shared message across multiple jurisdictions, agencies, and other stakeholders, to relay the message wide and far, since drivers cross such boundaries regularly and may not perceive the risks of being arrested, and/or being injured. They recommend including business leaders, insurers, law enforcement officers (including judges and prosecutors), victims of aggressive driving incidents, medical personnel, and many others in crafting the messages, laws, and enforcement strategies and deploying them.

NHTSA (2000) also suggests including strategies like a "tip line" (for citizens to report license plate and other details of violations), providing partners with a "stock speech" and other presentation materials, offering police-car ride-alongs to journalists and judges, and conducting enforcement in high visibility locations, during rush hour. Collecting and comparing performance metrics over time is valuable in gauging and reporting effectiveness of actions. Metrics include the shares of fatal crashes in a region where speeding and reckless driving are cited as factors, share of vehicles exceeding the posted speed limit by 15 or 20 mi/h or more on major roadways, annual number of speeding citations given, and shares of drivers who report speeding.

Examples Applications of Anti-Aggressive-Driving Strategies

Noteworthy examples of aggressive driving enforcement programs within the U.S. include Massachusetts' use of unmarked and non-traditional vehicles, with in-card video cameras and radar units, laws to request immediate license suspension and compulsory training of aggressive drivers (NHTSA 2000). Officers in Albuquerque, New Mexico have used trucks with extendable buckets to hold officers aloft with radar guns in hand, who then radio downstream patrol vehicles of violators. A Colorado Two Seconds for Safety campaign urged motorists to use a two-finger peace or victory sign to convey a quick message of thank you or please excuse me, and/or remind fellow motorists of the value of a two-second-headway (inter-car interval timing). The Colorado State Patrol's two-page annual report about deaths on the roadway, DUI arrests, and safety messages can be folded and handed to motorists at traffic stops. (NHSTA 2000) Newly elected judges in Ohio were offered "ride-alongs" inside planes to witness traffic issues from the air. Neuman et al. (2006) discuss the role of habitual offenders and policy champions, and offer additional details and strategy examples their NCHRP 500 report.

CONCLUSIONS

Aggressive driving behaviors may include multiple driving offenses, such as driving faster than conditions allow, following two closely, making unsafe lane changes, and running red lights (NHTSA 2010b). Aggressive driving not only tends to increase the likelihood and severity of crashes, but also interrupts traffic flow and adds to congestion. Aggressive driving can be caused by a driver's personal physical and psychological condition (e.g., immaturity and/or temporary stress) and/or by their environment (e.g., a congested commute and/or poorly timed traffic signals). According to NHTSA's 2002 survey, aggressive driving behaviors are perceived to be common, but they are difficult to measure (NHTSA 2004). Aggressive driving is unsafe driving that disregards safety and courtesy. The AAA Foundation (2009) found that most fatal crashes involve aggressive driving behaviors, such as running red lights or improperly changing lanes. Speeding is one of the most common forms of aggressive driving and is a contributing factor is about one-third of fatal crashes.

As discussed in this chapter, speeding is the most common type of aggressive driving and speeding-related crashes represent a high share of traffic deaths. Speeding relates to many

factors, including public attitudes, personal behaviors, vehicle performance capabilities, roadway design attributes, laws, and policies. Driver education, speed zoning, and speed enforcement are top recommendations for combatting excessive speed choices and other forms of driving aggression. Emerging technologies also offer much hope.

By avoiding conflicts and crashes, and reducing demands on drivers (Fagnant and Kockelman 2013), new and emerging technologies (like blind-spot monitoring, lane centering, fully self-driving vehicles, and smart-cycle intersections) will moderate driver frustrations and presumably reduce aggressive behaviors. Self-driving, or autonomous, vehicles will be designed to safely drive themselves, and may allow for shorter headways, higher capacities, and less roadway congestion. Such vehicles may well be programmed to never break the speed limit, change lanes without signaling, run red lights, or demonstrate other unsafe or hostile behaviors. Moreover, without steering wheels and foot pedals before them, drivers become passengers, and can focus on more meaningful and pleasant pursuits en route. Radio-connected vehicles with cameras can report on and document aggressive driving behaviors of other vehicles, potentially conventionally driven. Smart intersection control units may eventually double intersection capacities and keep traffic moving (Dresner and Stone, 2008). If self-driving vehicles are one day mandated, aggressive driving may remain possible only on special tracks, where competitors race against the clock or one another. Until then, millions of crashes annually and upwards of 50 percent of all roadway fatalities (AAAF 2009) remain a globally costly result of aggressive driving choices.

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