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# Pedestrian Impressions of Distracted, Aggressive, and Safe Walking Behaviors

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## ABSTRACT

Despite the attention that walking continues to receive as a means to promote health, ease traffic congestion, and reduce carbon emissions, the attitudes and feelings that pedestrians themselves have regarding walking have largely been ignored. To address this gap in research 268 college students participated in a study to assess their feelings as pedestrians. The general aim of the study was to determine pedestrian appraisals of safety and countermeasure efficacy at varying levels of intersection threat and different driver behaviors. Participants viewed intersections of varying threat levels (2-lane with 25MPH speed limit, 4-lane with 35MPH speed limit, and 4-lane with median with 45MPH speed limit) with different behaviors being exhibited by drivers travelling through the intersection (safe behaviors, distracted behaviors, and aggressive behaviors). Using the framework of the theory of planned behavior and the component process model of appraisal a questionnaire instrument was designed to assess pedestrians' feelings of safety, driver threat, control, and violation of social norms at intersections as well as the opinions of the efficacy of design, control, enforcement, and education countermeasures for each of the intersection threat x behavior combinations. Results indicated that overall pedestrian perceptions seem to be more impacted by intersection threat than by driver behaviors. Pedestrians report less control and increased violation of social norms as speed and number of lanes increase. Pedestrians reported feeling the least safe at intersections with distracted drivers and also reported these drivers as the highest violators of social norms. As with the safety appraisals of intersections, it appears that overall speed seems to have a greater impact on pedestrian perceptions of countermeasure efficacy than driver behaviors. Overall pedestrians seem to report greater efficacy for countermeasures at higher speeds. There also seems to be an optimistic view of efficacy in that if a pedestrian views a countermeasure as

effective the perspective persists across behaviors. Multiple regressions were run to explore the impact of general personality, specific personality, and driver stress variables on pedestrian perception factors, using a hierarchical entry method. The results of the regression analyses indicate that pedestrian perceptions are influenced by multiple personality factors. Indeed, many small individual biases may be working together simultaneously to shape perceptions of intersections and driver behaviors. Implications of the findings for pedestrian safety countermeasure design, increasing walking behaviors, and including pedestrian perceptions in assessments of an area's overall walkability are discussed.

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# CHAPTER 1

## Pedestrian Impressions of Distracted, Aggressive, and Safe Walking Behaviors

### General Concerns

In her testimony before the Congressional subcommittee on highways and transit, former Federal Highway Administrator [and former US Transportation Secretary] Mary Peters cited traffic congestion as a major quality of life issue in the United States (Peters, 2002). Indeed, alleviating traffic congestion has become a top priority of transportation professionals both in the United States and abroad. Encouraging people to walk or bike to locations is one way to help alleviate traffic congestion. Walking and bicycling are environmentally friendly and provide health benefits to the cyclist/pedestrian. Encouraging people to walk or cycle more frequently has the added benefit of being low cost (both to transportation authority responsible for implementing the program and to the user) and requiring little or no modifications to existing road geometry.

Although walking is a cost effective, environmentally friendly, and healthy solution to the traffic congestion problem, there are still some considerations that need to be made. The Federal Highway Administration states that most people prefer to walk when possible (Zegeer, et al., 2002). However, FHWA lists some barriers that may prevent people from walking. Among these are physical barriers to walking, the quality of the system, and feelings of personal safety.

Each year in the United States approximately 5,000 pedestrians are killed and another 69,000 are injured. Unlike other modes of transportation which may or may not be utilized by the population (e.g. cycling, driving, mass transit) everyone is a pedestrian at one point or another (Zegeer, et al., 2002). Establishing a safe environment for pedestrians is of paramount concern. Pedestrians may not feel safe in poorly lit environments, roads with no safe crossing,

and on facilities very close to the roadway. These are primarily issues of road infrastructure and can be addressed through a variety of engineering countermeasures. However, pedestrian safety may also be affected by the actions of drivers on the road. Of particular concern is how the behaviors of drivers on the road impact pedestrians.

**Previous Research Efforts**

There is little research addressing the issue of pedestrian reactions to driver behaviors and what research is available is presented from the drivers' perspective. Although the specific problem of pedestrian reactions to driver behavior has not been directly addressed, there is an ample body of pedestrian literature that touches either directly or indirectly on some aspects of the problem. Considering these previous efforts as a whole, there is enough background information to guide the development of the current research design.

**Pedestrian Safety**

According to the US Census Bureau, walking activity is rapidly decreasing (US Department of Commerce, 2004). The number of commuters who walk or cycle as a primary means of transport to work has significantly dropped as has the number of children walking to school (Killingsworth & Lamming, 2001). One reason individuals may be reluctant to walk may be that they do not feel safe as pedestrians. According to a US Department of Transportation survey, people would walk more if there were safe facilities and the expectation of crime was low (FHWA,1994). Indeed, a study by Hawthorne (1989) concluded that pedestrians would walk more given appealing walking facilities and safety from crime. High levels of inactivity have been correlated with the feelings that a person's neighborhood is unsafe (Weinstein, Felgley, Pullen, Mann, & Redman, 1999). However,

many empirical studies have failed to find significance between perceived safety and activity (e.g., Giles-Corti & Donovan, 2002; Sallis, Johnson, Calfas, Caparosa, & Nichols, 1997; Manson, Hu, & Rich-Edwards, 1995). These mixed results may be due to differences in methodology. Still, in all of these perceived safety was defined as personal safety from crime. The roles that drivers and driver behavior play in pedestrian feelings of safety have been largely unaccounted. However, driver behaviors may have a more imminent impact on pedestrian safety than the theoretical risk of being a victim of a crime.

**Accessibility.** The Americans with Disabilities Act (ADA) was signed into law on July 26, 1990. Title III of the Act deals specifically with public entities including transportation facilities. The Act requires that all persons regardless of disability must have equal access to public facilities. ADA requirements have led to the development of treatments such as curb ramps in sidewalks to enable the mobility impaired to easily transfer from a sidewalk to a street crosswalk and truncated (bumpy) domes at intersection areas to alert sight-impaired pedestrians that an upcoming area is shared with motor vehicles.

The ADA deals specifically with equal access for people of all abilities. However, it is generally thought that modifications made to comply with the ADA and make areas more accessible to those with disabilities benefit all pedestrians (Zegeer et al., 2002). It is also thought that areas that are accessible are considered to be more pedestrian friendly and thus encourage more people to walk (Hummel, 1999).

**Infrastructure and operational roadway characteristics.** The presence of a roadway itself in absence of drivers, points of interest, or safety features such as lighting or crosswalks may impact pedestrians' decisions to walk in a given area. Historically, roads have been designed for motor vehicles, not for pedestrians, cyclists, or other non-motorized road users (SAFETEA-LU §1202,

2005). Only recently has the accommodation of pedestrians been thought of in the roadway design process and not after construction (Smith, Reed, & Baker, 2010). The American Association of State Highway and Transportation Officials (AASHTO) book, "A Policy on Geometric Design of Highways and Streets" (AASHTO, 2004a), commonly known as the "Green Book", has long been used as the industry standard for design practices and roadway standards. The newer editions of the guide provide design standards for incorporating pedestrian facilities into new roadway construction. In conjunction with the Green Book, AASHTO has developed the "Guide for the Planning, Design, and Operation of Pedestrian Facilities" (AASHTO, 2004b). This guide, currently in its first edition, deals specifically with the need to accommodate pedestrians and provides design suggestions and solutions for new roadway construction and retrofitting existing roadways.

Solutions such as curb bulb outs, pedestrian refuge islands, and raised crosswalks can be easily implemented in new construction projects to make an area more pedestrian friendly. Road diets, where an existing road is narrowed to provide for bike lanes and medians, in-pavement crosswalk lighting, retroreflective crosswalk striping, and audible pedestrian crossing signals can be retrofitted into existing roadways at low to medium cost to make an area more pedestrian friendly.

**Societal walking norms.** Paramount for the issue of pedestrian walking is an area's pedestrian culture. Specifically, the pedestrian culture may dictate pedestrian behaviors by encouraging or discouraging walking. For example, the closure of part of Broadway in New York, NY, to motor vehicles made the area more appealing to pedestrians and cyclists alike (Cornog & Gelinne, 2010). New York City has taken further steps to increase the perceived pedestrian friendliness of its streets by creating seating along pedestrian thoroughfares as well as installing bike lanes and even sponsoring summer festivals to encourage walking in the area.

To get more people walking requires a cultural shift. Walking must be thought of as a primary mode of transportation and not a last resort. The Safe Routes to School (SRTS) program that was mandated by the SAFETEA-LU legislation is one example of this approach (SAFETEA-LU §1404, 2005). In 1969 approximately one half of school children walked or biked to school (FHWA, 1972). Current data reveal that now fewer than 15% of school children walk or bike to school and the majority of children arrive to school in a private automobile (FHWA, 2004). The goal of the SRTS program is to get more children to walk or bile to school. This aim is being accomplished through outreach, education, improved sidewalks and crosswalks, and school incentives.

**Encouraging Walkability**

Appropriate pedestrian facility design can increase quality and quantity of walking, in terms of both provision of crossing facilities and in terms of overall design (Sisiopiku & Akin, 2003). Residents of compact, mixed use neighborhoods are three times more likely to walk to a destination than those living in more spacious neighborhoods more suited to automobile travel (Cervero & Radisch, 1996).

Pedestrian needs and preferences can be determined by assessing the "walkability" of a particular route using a scoring or checklist approach. These approaches usually use a best practices model for determining what pedestrian factors to include that make an area more appealing to pedestrians. These tools are often used by transport authorities and consultants. One such tool, the Pedestrian Environment Review System (PERS) (TRL Software, 2004), allows pedestrians to rate a range of factors about a pedestrian route. The aggregation of these results enables the operator to identify specific features which should be improved. The pedestrian level of service (LOS)

methodology is another approach which provides a measure of walkability by examining design factors, location factors, and user factors (Gallin, 2001). These elements are taken together and a weighting system is then applied as certain factors are more important to pedestrians. A route is then given a LOS grade from A (representing the most walkable) to F (least walkable). This information can then be used by transportation professionals to determine those routes in need of treatment.

The concept for the pedestrian LOS model is taken directly from the literature on roadway LOS (see AASHTO, 2004a and Transportation Research Board, 2000 for a review). However, determining roadway LOS is a straightforward procedure. Specifically, roadway LOS uses number of vehicles per hour, vehicle speed, road material (e.g. asphalt) condition, and vehicle delay to calculate a LOS grade from A (free flowing traffic) to F (roadway capacity exceeded, vehicles stop and start on roadway while travelling below posted speed). Determining pedestrian LOS is not nearly as straightforward. In addition to easily measured items such as the presence or absence of a sidewalk, physical condition of walking facilities, and the number of pedestrians who could be comfortably accommodated by a facility there are several items that may impact pedestrian LOS but which are difficult to quantify. Specifically, pedestrians' own feelings and opinions about a walkway may impact an area's LOS. By the numbers a given walkway may seem very appealing and be assigned a grade of "A" for LOS. However, that same walkway may be viewed as unappealing by pedestrians and hence the "A" walkway may actually have a practical LOS of "D". Unlike roadway LOS the calculation of pedestrian LOS is still in its infancy. Most research on pedestrian LOS is less than ten years old whereas roadway LOS has an established methodology and data going back well over 50 years. Additionally, the LOS approach considers the user (pedestrian) only in terms of pedestrian volume and does not give consideration to pedestrians' feelings of safety or their considerations as to the walkability of an area.

Other examples of methodologies for assessing the walkability of the pedestrian environment focus on checklists or observations that are completed by pedestrians. Nabors et al. (2007) produced a "walkability" checklist, which asks residents to assess their local community (e.g. Did you have room to walk? Was it easy to cross the street?). In these methods the role of driver behavior on pedestrians' decisions to walk is either ignored completely or given only a perfunctory mention.

**Complete streets.** The complete streets paradigm is based on the idea that all users should have equal access to roadways whether they are motorists, cyclists, pedestrians, or transit users. The notion of 'complete streets' is not a new one. Several European countries have designed roadways using this paradigm for many years. However, the push for complete streets is just beginning to gain momentum in the United States. The Complete Streets Act of 2009 (H.R. 1443) is currently being debated by Congress. If signed into law, it would mandate that all newly constructed roadways be accessible to all users of the transportation system.

Although not yet law, the current policy of the United States Department of Transportation is that provisions should be made for all users in new roadway construction projects (LaHood, 2010a). Complete Streets solutions look at factors including roadway geometry, operations, lighting, safety, traffic calming, and transit. These solutions should be context-sensitive, enhancing the unique characteristics of a community – whether urban, suburban, or rural.

Ideally, any complete streets solution would also take into account the opinions of pedestrians regarding driver behavior, roadway design, and the efficacy of countermeasures. This in turn will help to insure that when new roadways are constructed pedestrians feel safe

**Community livability as a right.** In a June 16, 2009 press release Transportation Secretary LaHood in conjunction with HUD Secretary Shaun Donovan and EPA Administrator Lisa Jackson

announced an interagency partnership for sustainable communities. As part of this partnership six livability principles were identified. These principles are:

1. Provide more transportation choices
2. Promote equitable, affordable housing
3. Enhance economic competitiveness
4. Support existing communities
5. Coordinate policies and leverage investment
6. Value communities and neighborhoods

The first of these principles involves transportation choices, especially those which reduce US dependence on foreign oil. Walking is a low-cost, environmentally friendly, and relatively easy transportation option. However, many potential pedestrians may be reluctant to walk based on concerns over safety. Pedestrians need safe and easy access to transit, shops, housing, etc. There needs to be an understanding of why pedestrians choose to walk or not walk and what can be done to get them to their destination as safely as possible.

Another of these livability principles is to support existing communities. This effort includes strategies like transit oriented, mixed-use development and land recycling. An integral component of this is making existing communities more pedestrian-friendly.

Coordination and leveraging of federal polices and investment is another livability principle. Pedestrian solutions therefore need to be multi-faceted. Solutions should include (but are not limited to) safety, planning, environment, education, ADA, enforcement, geometry, accessibility, speed management, and traffic volume.

Valuing communities and neighborhoods is the final livability principle. Any pedestrian solution should ultimately make the area more appealing to pedestrians and thereby more walkable.

It is clear from this joint statement from Secretary LaHood and others that safe access to all transportation options, including walking, is being treated as a priority, and safe and walkable communities are being viewed as a right of all American citizens. Given the priority the issue of walkable communities has been given, it becomes all the more important that the pedestrian factors relating to this issue be understood.

Indeed, there are several legislative bills that directly or indirectly impact pedestrians and urge the creation of a more pedestrian-friendly community. These bills include the Active Community Transportation Act ("The ACT Act") *(*HR 4722*)* which would provide local grants to improve pedestrian and bicycle access to roadways, The Enhancing Livability for All Americans Act *(*HR 4287) which would create an office of livability in the USDOT to encourage complete streets developments, and The Safe Routes to High Schools Act (HR 4021*)* which would expand the SRTS program to high school students. This proposed legislation may be a sign that the culture is changing and moving towards a more pedestrian friendly transportation system.

**Walkability from a pedestrian perspective.** The impact of distraction, aggression, and 'road rage' on other drivers and the personality characteristics of these drivers are both topics that have received a good amount of attention in recent years. However, the effect of road rage and distraction on road users other than drivers (i.e., cyclists, pedestrians) has largely been ignored. It is plausible that these behaviors may influence pedestrians' perceptions of safety. In the absence of research addressing this issue the extent to which aggressive and distracted driving behaviors impact pedestrians is currently not known.

The present study will attempt to address this gap in the research. Previous research of this nature has focused on the driver's perception of what pedestrians may find aggressive (e.g., Sarkar & Andreas, 2004) but currently there is no known study examining the pedestrian's

perception of these aggressive behaviors. There is also no known study examining the effects of distraction on pedestrians from either the driver or the pedestrian perspective. Understanding how aggressive and distracted driver behaviors impact pedestrians' cognitive, affective and behavioral responses to walking in proximity to traffic is a necessary prerequisite to the development of countermeasures and ultimately to the increase in pedestrian safety.

**Driver Types**

Frequently, when discussing pedestrian access to facilities, pedestrians and motorists are thought of as completely separate and independent entities. That is, many transportation planners when designing a new roadway will design certain facilities for road users and other facilities for pedestrians, but when designing do not take into account that the pedestrians and motorists will at some point have to interact with each other. This omission can potentially be problematic as these designs may prove to be ineffective in the instances where pedestrians and motorists come in contact with one another. For example, an established crosswalk countermeasure that has been empirically shown to reduce pedestrian crashes at a certain facility type (e.g., a four lane high speed arterial) may be completely ineffective at a different facility type (e.g. a two lane rural road). Worse, the efficacy of that countermeasure at a facility type may be unknown because the pedestrian views the crossing where the countermeasure has been installed as dangerous and therefore chooses to cross elsewhere (or to use another method of transportation).

In addition to the actual roadway geometry, the behavior of the motorists using the roadway may impact pedestrians' decisions to walk. Aggressive drivers have received a great deal of attention in the last several years. The term 'road rage' is one that is all too frequently used when reporting on traffic crashes and fatalities. The National Highway Traffic Safety Administration

(NHTSA, 2002) has developed a guide for reducing aggressive driving behaviors through education and enforcement techniques. Crash and fatality reports provide a post-hoc view of aggression. That is, a crash report may fault an aggressive driver as the cause of a crash or fatalities. However, it is not known if or how those aggressive driving behaviors impact a pedestrian's decision to walk (or not walk) in a given area.

Distracted driving is a safety issue that has received a great deal of attention but of which even less is known. The importance of the problem of distracted driving can be evidenced by the emergence of a government website (www.distraction.gov) devoted to educating people on driver distraction. In September of 2009, Transportation Secretary LaHood convened the first distracted driving summit in Washington, D.C. This is now slated to become an annual event and planning is well underway for the 2010 summit. Again, from post-hoc crash reports it is known that distraction is a factor in vehicle/pedestrian crashes but it is not known if this behavior has any impact on an individual's decision to walk.

**The aggressive driver.** Road rage has become an increasing problem (Boyce & Geller, 2002). Once behind the wheel, many drivers forget the common courtesies they extend in other aspects of life. Aggression and thrill-seeking traits have been implicated in higher frequencies of accident involvement and speeding violations as assessed by self-report (Matthews, Desmond, Joyner, Carcary, & Gilliand, 1996). Drivers with high scores on these scales also report frequent deliberate violations of road safety, together with inadvertent errors. That is, these drivers are more likely to choose to engage in such behaviors as running red lights, 'lane hopping' in busy roadways, and tailgating. Simulator studies confirm that aggression predicts faster speed and more frequent passing (Matthews et al., 1998). Aggression is a reliable predictor of anger states during driving. Aggression is also strongly associated with confrontive coping, which refers to coping through

expressing hostility to other drivers, such as gesturing, honking the horn, and tailgating. Thus, dangerous behaviors associated with aggression may be a product of coping with frustration and anger by engaging in confrontation with other drivers appraised as hostile.

A study by Deffenbacher, Lynch, Filetti, Dahlen, and Oetting (2003) found that drivers categorized as high in anger reported more anger across all driving situations (from very low/no roadway congestion to heavily congested freeways). The authors posit that the anger state directly influences risk-taking behavior. Possibly, tendencies to become angry and distressed during initial driver training may contribute to development of these habitual styles of behavior, but research directed towards early skill acquisition is needed to test this hypothesis.

Compounding the problem of understating aggressive driving is that there is no standardized definition for aggressive driving or aggressive drivers. Some research studies have used the terms road rage and aggression interchangeably. However, it could be argued that the propensity towards being an aggressive driver is a personality characteristic whereas road rage is an action that demonstrations aggression and/or frustration. Still, the inconsistencies in terminology can lead to confusion as to what driver thoughts or behaviors the term aggressive driving is referring. There are three aspects of driving behavior that have been labeled as aggressive driving or road rage in the literature:

1. Intentional acts of physical or verbal, aggression including lewd gestures;
2. Negative emotions such as frustration and anger; and
3. Risk-taking behaviors (Dula & Ballard, 2003).

A call to the research community for a standard definition of aggressive driving and drivers to be used in all empirical research has been placed (Dula & Geller, 2004) but based on the continued practice of researchers applying their own definitions of ‘aggression’ as they relate to their

specific projects, this advice has gone unheeded. Using a system of stages or levels for aggression has also been proposed (Sarkar, Martineau, Emami, Khatib, & Wallace, 2000). This approach takes into account the multifaceted and complex nature of driver aggression but it, too, has not been widely adopted.

The problem of how aggression is defined as it related to drivers notwithstanding, there is currently little understanding of the effects of aggressive drivers/driving on pedestrians and how these behaviors impact decisions to walk. The little research available that recognizes that these behaviors may have some impact on pedestrians decisions to walk in an area look at the problem for a driver's perspective of how their aggressive behaviors may impact a pedestrian (e.g., Sarkar & Andreas, 2004, 2006).

**The distracted driver.** Much of the attention that is focused on distracted driving concentrates on in-vehicle information systems which are integrated within the vehicle and nomad systems (e.g., portable GPS, laptop computers, cell phones, etc.). Research efforts that focus on driver distraction typically focus on the effects of one or two distracting devices on driver performance. Distraction research tends to focus on specific age groups such as teenagers or older drivers. It should also be noted that the majority of currently available research on distracted driving is commissioned by interest groups on either side of the issue. This research seems to be primarily motivated by device manufacturers with the need to show that a particular device is not distracting to a driver, or public safety groups attempting to demonstrate that a device is distracting.

In fact, cellular telephones and other in-vehicle technologies have received the most attention of the research community while little attention has been given to identifying non-technological driver distractions and their role in driver performance. Tasca (2005) categorized driver distraction into four categories: auditory, visual, biomechanical (e.g. adjusting the radio), and cognitive (e.g.

being “lost in thought”) representing the multi-faceted nature of driver distraction. Distraction can come from a myriad of sources including passengers, billboards, animals, and other outside sources. Wierwille and Tijerina (1998) demonstrated a relationship between an increase in visual demand of in-vehicle information systems and accident involvement. This finding indicates that some seemingly helpful devices can also be a hindrance and devices designed purely for entertainment may be more risky than beneficial.

A study by Tsimhoni (2003) found that drivers’ glance durations at a distracting device were shorter in complex road environments, perhaps in an attempt to meet the driving demands of the roadway. However, even given the briefer glances, results indicated that driving performance was still degraded as evidenced by frequent lane departures.

Reaction time also seems to suffer as a result of distraction. Lee, McGehee, Brown, and Reyes (2002) found that distracted drivers took longer to brake in response to the braking behavior of a lead vehicle. Lamble, Laakso, and Summala (1999) found similar results with distracted drivers taking longer to react to a decelerating vehicle. A simulator study showed faster reaction times by participants looking at head up displays as compared to head down displays (Horrey & Wickens, 2004). However, reaction times for both groups were greater than those who were not looking at a display. These findings are especially relevant for pedestrians. A pedestrian may see a car in the distance and begin to cross the street under the assumption that the driver will yield to the pedestrian upon approaching the crosswalk. However, a distracted driver may not see a pedestrian in time and therefore fail to slow the vehicle sufficiently in advance of the crosswalk.

Since taking office, Department of Transportation Secretary Ray LaHood has pledged that road safety is his number one priority and as a major step towards safety he has taken a “rampage” against distracted driving (LaHood, 2010b). Distracted driving has become a top national priority

and even the popular media has become involved. Given the broad national attention that driver distraction has recently received, it is likely that more research on the effects of driver distraction will be forthcoming and this research will focus more broadly on the impact of distraction on driver performance. Regardless of the etiology of the distraction, a distracted driver has fewer resources to allocate to roadway elements (including pedestrians) than an attentive driver.

**The courteous driver.** The courteous driver is thought by most to be the ideal roadway user. Researchers typically use the terms 'courteous driver' and 'safe driver' interchangeably. It is important to note that courteous driver behaviors do not guarantee safety. For example, a courteous driver may yield to a pedestrian in a crosswalk only to be involved in a rear-end collision with a following driver not attentive to the courteous driver's yielding behavior. For the purposes of this discussion the assumption will be made that courteous drivers are also safe drivers even given the caveat above.

Most research on safe driving focuses on behaviors such as distraction and aggression which are considered unsafe rather than focusing on the characteristics of a safe driver. Typically, the available research cites the absence of characteristics such as risk taking and making unnecessary driving maneuvers when describing the safe driver (e.g., Quenault, 1968). Hakamies-Blomqvist (2006) goes so far as to argue that there are no absolute driver characteristics that indicate a safe driver. Of the research that does exist on safe driving the most common attribute studied is that of driver courtesy (e.g., Hutchison, 2008).

It has been suggested that safety skills can be incorporated into driving skills and become part of a driver's automatic driving behaviors (e.g., McKenna, 1993). However, it is also possible that drivers overestimating their driving and safety skills may in fact lead to overconfidence and the commission of careless errors (McKenna, Stainer, & Lewis, 1991). When asked, drivers tend to

overestimate their safety skills and rate themselves as safer drivers when asked to compare themselves with others (e.g. Walton, 1999; Walton & Bathurst, 1998). This inflated belief in one's own safety skills may in turn lead to more dangerous driving or a higher level of risk acceptance (Groeger & Brown, 1989). Thus, it is possible that drivers who believe they have above average driving and safety skills may be more dangerous than those with moderate abilities.

The elusive nature of a standard definition of 'safe driver' and the possibility of overconfidence in safety leading to driver errors notwithstanding, the safe driver tends to be the ideal driver when considering pedestrian safety (Zegeer, et al., 2002).

**Pedestrian Behavior and Appraisal at Crossing Locations**

Despite the attention that walking continues to receive as a means to promote health, ease traffic congestion, and reduce carbon emissions, the attitudes and feelings that pedestrians themselves have regarding walking have largely been ignored.

There is a great deal of literature (see Zegeer, et al., 2002, for review) available that indicates engineering treatments that increase pedestrian safety. These treatments, such as creating bulb-outs or chicanes, eliminating through lanes by means of a "road diet", creating pedestrian refuge islands in medians, or installing pedestrian countdown crosswalk signals, have all been shown to reduce pedestrian fatalities and serious injuries. By extension, it is assumed that reducing crash risk makes an area more walkable. However, this ignores the opinions of the pedestrian. An individual's decision to walk undoubtedly involves more than just the perceived risk of being involved in a crash. How pedestrians subjectively view an intersection may greatly impact their decisions to walk and indeed their opinions as to the walkability of an area.

**Component process model of appraisal.** Modern theories of emotion owe a great debt to the pioneering work of Lazarus (1966). Unlike previous theories, Lazarus proposed a dynamic theory of emotion where emotion resulted from an individual's appraisal of an event and not necessarily anything inherent to the event itself. This perspective allowed for a better understanding of how two individuals experiencing the same event can have different emotional reactions or how one person can have different emotions based on the same event depending on their appraisal of that event.

The Component Process Model of Appraisal (CPM; Scherer, 2001) builds on the insights of Lazarus (1966) to provide an elaborate framework for emotion and underlying mechanisms. It can be useful in understanding emotional processing and specifically the role of consciousness in that processing. The CPM has four main Appraisal Objectives:

1. Relevance;

2. Implications;

3. Coping Potential; and

4. Normative Significance.

According to the theory it is expected that these appraisals occur sequentially (Sander, Grandjean & Scherer, 2005). At each step in the appraisal process other mechanisms such as attention, memory, reasoning, and motivation provide information to assist in the appraisal.

Relevance detection is the first and most basic appraisal level (Grandjean, Sander, & Scherer, 2008). This first stage is appraisal at its most primitive. Appraisals at this point are based on whether an event has any direct implications for a person or that person's social group. To help determine relevance, three sub-processes are activated: novelty, overall intrinsic pleasantness, and goal relevance. Checking an event for novelty allows an individual to determine if it is something

that has been encountered in the past and hence has a predictable outcome or response that can be drawn upon to determine an action. In determining relevance, appraisal of intrinsic pleasantness enables a person to determine if an event is likely to be pleasant or unpleasant and an action can be determined based on the desire to pursue pleasure or avoid pain. Lastly, assessing goal relevance enables an individual to determine if an event will impact overall goals. The impact could be immediate and serious (e.g. not acting could result in death) or long term and more abstract (e.g. acting could set off a chain of events that could prove to be fortuitous in the future). Unlike the other sub processes, goal relevance may be mediated by other factors such as motivation (Austin & Vancouver, 1996). If it is determined that the event is not relevant, no further appraisal is needed.

According to the CPM the second appraisal stage is the implication assessment. Here, the major goal is to determine what might (or might not) happen as a result of an event. The implication assessment stage has five separate sub processes: causal attribution, outcome probability, discrepancy for expectation, goal conductivity, and urgency (Grandjean et al., 2008). During causal attribution an individual determines the "what" and "why" of an event. That is, what action or inaction caused an event to happen and why that action (or inaction) may have occurred. An individual next determines the likelihood of the event occurring, the probability it might occur again, and what the outcome might be given different courses of action. Next, an individual evaluates if the event is routine or out of the ordinary. Routine events likely have routine responses. For example, if I am stuck in traffic and it is five p.m., it's reasonable to assume these are typical rush hour delays and I need do nothing more than inch along the highway. On the other hand, if I am stuck in traffic and it is three a.m. it is likely that there has been a traffic accident or some other event and it may be advantageous for me to take an alternative route. The determination of the behavior or emotion resultant of an event is impacted by the conductivity of the event. If an event is

perceived as helping lead an individual towards a goal pleasant emotion is expected. If it is perceived as helping to lead an individual away from a goal negative emotion is expected. Lastly, the urgency of the event is assessed. At this stage an individual can determine if the event is an imminent danger, a threat to an important goal, and if it requires immediate action or if response can be deferred. If the implications of the event are not immediate, no further action is required.

The third appraisal stage is coping potential. At this stage an individual determines what actions can avoid negative events, or at least mitigate negative consequences. There are three sub-processes at this stage: control, power, and adjustment. Control is concerned with determining if intervention can change the course of an event. For example, if I am stuck in traffic because there are too many other road users currently on the road, the event could possibly be controlled. In contrast, if the traffic jam is due to a fallen tree obstructing the roadway, the ability to control is much less. The next step is determining the power to affect change. In the above example, the traffic jam situation with too many other cars could be controlled, but I lack the power to make any changes. Lastly, an individual determines if the event can be adjusted. Since I have no power to change the traffic situation, I can take traffic jams as part of living in a large metropolitan area and adjust my behavior by using my time in traffic to listen to books on tape or modify my schedule so I am not travelling at peak times.

The fourth and final appraisal stage in CPM is the evaluation of normative significance. Here an individual must determine how other individuals in a group react to that event. The two sub processes involved at this stage are an internal and external standards check. The internal standards check evaluates how an event matches the individual's moral expectations or desirable characteristics. The external standards check seeks to match the event to these same attributes but at the level of a relevant group.

Using the CPM framework it may be possible to gain insight into pedestrians' decisions to walk and ultimately how they determine the walkability of an area. For example, a pedestrian may look at the behaviors of drivers and determine if their behaviors will impact their decisions to cross at a crosswalk (relevance). If those behaviors are relevant to the pedestrian, the pedestrian may then determine the consequences of crossing given that behavior (implications). The pedestrian may then determine how to adjust to or cope with those consequences (coping potential). Finally, and perhaps most importantly, in determining the overall walkability of an area, the pedestrian will determine how this behavior fits in with societal norms and values (normative significance).

CPM implies that there may be multiple attributes of the traffic environment that influence pedestrian behavior. Driver behavior, in conjunction with roadway design, may influence relevance and implications, in that that a perceived threat to safety is both relevant, and carries implications for personal wellbeing. Relevance may derive both from anticipating that the crossing will be subjectively unpleasant (low intrinsic pleasantness) and from appraising some likelihood of personal injury (threat to goal of staying healthy). Appraisals of control may relate especially to design features of the crossing such as the availability of a push-button to stop the traffic. Typically, pedestrians have little scope for influencing the behavior of drivers. By contrast, normative significance is most relevant to perceptions of drivers. Appraisals of safety are likely to be influenced by the extent to which drivers are believed to adhere to a social norm of taking care to avoid intimidating or actually colliding with pedestrians. However, a limitation of the CPM is its complexity, given that each appraisal stage has multiple sub-processes. Especially in exploratory research, it may be difficult to evaluate and distinguish these multiple processes.

**Theory of planned behavior.** The Theory of Planned Behavior (TPB; Ajzen, 1988) can also be used to understand pedestrians' crossing decisions and the determination of an area's walkability.

TPB was developed as a method to predict behavior. Ajzen and Fishbein (1977) note that general attitudes are poor predictors of behaviors. The assumption behind TPB is that the aggregation of different behaviors observed at different times and in different settings results in a more valid measure of behavior prediction than any single underlying behavior. The Theory of Planned Behavior (Ajzen, 1988) was designed to predict and explain behavior in specific context by focusing on an individual's intention to perform a task or behavior. This theory provides insight into a person's motivation and the level of effort willing to be exerted to complete a task. These factors can be measured by an individual's intention to perform a task (the need to move from point A to point B) and the ability of that individual (being able to locomote either independently or with the use of assistance).

TPB suggests that a person's intention to engage in a behavior is influenced by three factors:

1. Perceived behavioral control;
2. Attitude towards the behavior; and
3. Subjective norms (Ajzen, 1991).

Ajzen (1991) distinguishes between actual behavioral control and perceived behavioral control. Actual behavioral control is quite straightforward: it is the extent to which a person has the resources and abilities at his disposal to achieve a behavior. Perceived behavioral control is more elusive. Perceived behavioral control is the defining feature of TPB and distinguishes it from earlier theories such as the theory of reasoned action (Ajzen & Fishbein, 1980). Perceived behavioral control is an individual's own belief in the ease or difficulty in achieving a behavior (Ajzen, 1991). Perceived behavioral control differs from locus of control (Rotter, 1966) as locus of control tends to be stable and perceived behavioral control changes based on different actions or situations. For example, with an internal locus of control I may know that my devotion to

rehearsing will impact my success as a ballerina. However, given my age, I have a low perceived behavioral control indicating the chances of becoming a ballerina are slim. Unlike the other factors in the model, Ajzen (1991) asserts that perceived behavioral control impacts both the intention to perform a behavior as well as the behavior itself.

Attitude towards a behavior includes affective attitude and instrumental attitude. Affective attitude is concerned with the overall pleasure derived from a given behavior. Behaviors viewed as more pleasant may strengthen the intention to carry out a behavior. Instrumental attitude is concerned with the overall perceived usefulness of a behavior. A behavior viewed as very useful may also strengthen the intention to carry out a behavior.

Subjective norms are the last factor influencing attention. Subjective norms are the perceived social pressure to perform a behavior. Stronger perceived social pressures may strengthen the intention to perform a behavior. TPB has been successfully used to predict physical activity and driver behaviors. A meta-analysis of physical activities found that TPB could explain 29% of the variance in physical activity (Hagger, Chatzisarantis, & Biddle, 2002). This percentage was similar to the effectiveness of TPB at predicting other behaviors (Armitage & Connor, 2001). The results of the meta-analysis showed that people's attitudes, and to a lesser extent perceived behavioral control and self efficacy, appear to be the main influences on intention to perform a behavior (in this case, physical activity) (Hagger et al., 2002). From these findings it seems that interventions designed to enhance attitudes towards physical activity may lead to an increase in physical activity. When applying these findings strictly to pedestrians and walking behaviors, it may be that increasing walkability involves discovering what variables impact pedestrian attitudes about walking and developing countermeasure treatments that enhance these attitudes. For example, if pedestrian attitudes are impacted positively by the

presence of a raised crosswalk or more visible enforcement activities, it may be worthwhile to increase the number of these types of treatments to encourage more walking behaviors.

Currently, only one known study has used TPB to specifically predict walking behaviors (Eves, Hoppe, & McLaren, 2003). Most previous studies looked at physical activity (i.e. exercise) as a whole. The Eves et al. (2003) study examined six types of physical activity: team sports, swimming, aerobics, dancing, cycling, and walking. It should be pointed out that, as physicians, the authors' main concern was public health. The results from this study were similar to those reported in the meta-analysis. Specifically, the authors found that perceived behavioral control and affective attitude predicted intention. However, attitudes alone predicted behavior. In their study, TPB was used to predict walking for exercise rather than walking for transport. Furthermore, the authors defined a regular walk as one lasting at least 30 minutes, discounting short walks that may be common when walking is used as a means to get from point A to point B. It may also be useful to note that pedestrians choosing to walk for exercise may do so on trails, paths, or walkways designed for this purpose and since there is no fixed destination, pedestrians may ultimately choose a route that is most appealing. This approach therefore discounts the impact roadway geometry, intersection characteristics, and driver behaviors may have on walking decisions.

According to Ajzen (1991), interventions designed to change behavior can be directed at one or more of the behavior's determinants (i.e. attitudes, subjective norms, perceived control). Ajzen argues that changes in one or more of these determinants should produce changes in behavioral intentions and these new intentions should result in the performance of the new behavior.

TPB has been used as a framework to develop transportation related interventions for driver speed reductions (Stead, Tagg, MacKintosh, & Eadie, 2005) and seat belt use (Brijs, Daniels, Brijs, & Wetts, 2010). Given its successful use in predicting physical activity (e.g. Hagger et al., 2002) and walking behavior specifically (Eves et al., 2003), it is reasonable to assume that the TPB framework could be successfully used to design interventions to increase walking behaviors.

Using the TPB framework, additional insight into pedestrians' crossing decisions may be gained. Specifically, it allows us to determine the strength of pedestrians' desires to walk (rather than choose another mode of transportation), how much effort they are willing to expend (e.g., willing to navigate difficult terrain or busy crossing situations?), and their actual ability to achieve their goal of crossing (e.g., are walking abilities such that obstacles can be overcome and lead to a successful cross?). This information can then be used to develop interventions to increase walking behaviors and ultimately make areas more walkable. This increase in walkability should have the beneficial side effects of increasing physical activity, improving cardiovascular health, and reducing obesity.

**Summary: A conceptual framework for research on pedestrian perceptions.** The impact of driver behaviors and 'road rage' on other drivers and the personality characteristics of the aggressive and distracted driver are topics that have received a good amount of attention in recent years. However, the effect of these driver behaviors on road users other than drivers (i.e., cyclists, pedestrians) has largely been ignored. There is little doubt that aggressive and distracted driving potentially impact pedestrians' perceptions of the safety of crossing roads. In the absence of research addressing this issue the impact on pedestrians is currently not known.

It is likely that there are multiple factors that shape pedestrians' perceptions of the safety of crosswalks. These include physical features of the crosswalk, as well as perceptions of driver behavior, and the individual's personality and emotional state. Much research has focused on the physical features of the roadway environment and pedestrians' opinions about that environment. The present study will address the gap in research related to the pedestrians' perspectives of other road users (e.g., drivers) and their own personality and emotional state and how these impact decisions to cross the road using the framework of both the Theory of Planned Behavior (Ajzen, 1988) and the Component Process Model (Scherer, 2001).

Both CPM and TPB have limitations as frameworks for investigating pedestrian perceptions of crosswalks. They also differ, in that CPM focuses on 'input' (appraisal) and TPB on 'output' (choice of behavior). As already noted, the CPM may be overly complex for exploratory research. The limitation of the TPB is that it has been applied primarily to patterns of behavior, such as regular exercise, performed over extended time periods. By contrast, using research on pedestrian perceptions to improve crosswalk design requires a focus on pedestrian response to single, specific crosswalks. In the USA, it is unlikely that a crosswalk would be so intimidating that a pedestrian would be deterred from completing a planned journey. Thus, the key issue is not whether pedestrians choose to cross or not, but their quality of experience, in that unpleasant experiences are, over time, likely to discourage walking.

There appears to be sufficient convergence between the constructs of the CPM and TBP to differentiate three key aspects of the pedestrian's appraisals: *safety vs. threat*, *controllability*, and *social norms.* From a practical standpoint, it may also be important to differentiate safety/threat appraisals of the physical qualities of the roadway (calling for engineering solutions) from appraisals

of driver behavior (calling for behavior modification). In more detail, the key appraisal constructs to be investigated in this study are as follows:

First, the pedestrian has beliefs about the extent to which the crossing is safe and pleasant to use, as opposed to being dangerous, threatening, and stressful. These beliefs correspond directly to appraisals of intrinsic pleasantness in CPM, and perhaps to other subprocesses supporting appraisals of relevance and implications. In TPB beliefs (attitudes) attach to behaviors and their expected outcomes rather than to features of situations or environments per se. However, it is likely that a negative experience of a crosswalk would influence a belief that street-crossing behavior would have a negative outcome. Indeed, in CPM, the outcome probability subprocess may similarly create an expectancy that crossing the street will lead to an unpleasant experience. In this context, it may be important to distinguish beliefs about the crosswalk design from beliefs about driver behaviors.

Second, the pedestrian has beliefs about the controllability of the crossing section and the extent to which they can cope with its demands successfully. CPM defines coping potential as one of the aims of appraisal, and TPB sees perceived behavioral coping as a fundamental influence on intentions. Third, both theories indicate the importance of social norms. Pedestrians will evaluate the extent to which the threats posed by drivers are held in check by shared values of preserving pedestrian safety, backed up by road safety laws.

As mentioned previously, the Theory of Planned Behavior can be used not only to predict behaviors but also to develop interventions to produce behavioral changes. However, little previous research has been conducted on pedestrians' perceptions of what countermeasures for improving crosswalks would be most effective. The three basic elements of TPB suggest alternative strategies for intervention. First, attitudes towards using crosswalks may be enhanced. Various strategies might be used, but perhaps the simplest is to enhance the design of crosswalks to make the crossing

experience more pleasant and less stressful so as to influence affective attitude. Second, interventions might focus on enhancing the pedestrians' sense of control, for example, by providing the means to slow traffic. Third, pedestrians' beliefs that drivers will conform to appropriate social norms may be enhanced, through interventions based on enforcement and education. Enforcement relates directly to TPB subjective norms as its aim is to exert social pressure on the driver. Behaviors threatening to pedestrians become looked upon as undesirable and ultimately a change in driver behavior should result. Conversely, education may be used to train drivers in courteous behaviors. However, there are further nuances to the relation between education and attitude. Driver education may seek not only to change social norms but also to change instrumental attitudes, concerned with the overall perceived usefulness of a behavior. Drivers might be instructed that courteous behavior towards pedestrians will increase their own safety, and reduce the probability of being sued. According to TPB, increasing perceptions of the usefulness of safe driving should increase the likelihood that the desired driving behaviors are actually performed.

**Individual Differences in Pedestrian Perception**

Previous research on pedestrian behavior has largely ignored individual differences, although it is plausible that people vary in their affective, cognitive, and behavioral responses to walking. Encouraging people to walk may require a special focus on those individuals whose attitudes to walking are the most negative. The analysis of pedestrian perceptions in relation to CPM and TPB may also guide investigation of individual differences. Perhaps, some individuals are prone to appraise crosswalks negatively by seeing them as threatening, outside of personal control, and/or inadequately protected by social norms. Individual differences might similarly be characterized in relation to the constructs of TPB. As stated previously, attitudes appear to be the

main influence on performing a behavior (Hagger et al., 2002). Since the majority of studies of walking focus more broadly on long-term physical activities, attitudes of pedestrians are currently unknown. How an individual's personality in general, or driver personality traits specifically, may impact attitudes as a pedestrian are currently not known.

**Role of general personality factors.** Some research has been conducted on the role of general personality factors, such as the 'Big Five' traits of the Five Factor Model (Goldberg, 1993), in physical exercise and walking. A meta-analysis reviewing the available literature on personality and physical activity found both extraversion and conscientiousness to positively correlate with physical activity (Rhodes & Smith, 2006). This same meta-analysis found neuroticism to be negatively correlated with physical activity. In all cases, the effect sizes were small. This study, like the majority of related studies, looked at walking behavior as one of various forms of physical activity. Almost no research exists that evaluates personality and walking specifically (and not as part of a larger group of physical activities). One study looking at physical activity found extraversion to be positively correlated with vigorous forms of physical activity, but did not find any relations with walking for exercise (Howard, Cunningham, & Rechnitzer, 1987). Again, only walking behaviors related to exercise were included. Rhodes (2006) conducted one of the few studies to look at both TPB constructs and personality differences as predictors of walking behavior. His findings suggest that personality does not directly predict walking behavior. However, he found that personality, specifically conscientiousness, positively influences intention and behavior. Follow up research again found conscientiousness to positively influence walking intention and behavior (Rhodes, Courneya, Blanchard, & Plotnikoff, 2007).

However, TPB constructs have not been found to fully mediate the impact of personality variables (e.g. Rhodes, 2006, Rhodes & Smith, 2006). Rhodes and Smith (2006) have suggested that

this finding may be due to the stability of personality characteristics in contrast with the more transient predictive ability of the social cognitions of TPB across time. Personality may also influence appraisal and coping of walking behaviors, given that several Big Five traits have been shown to relate to these processes in stressful environments (Matthews, Deary, & Whiteman, 2009). For example, conscientiousness is associated with task-focused coping (Matthews, Emo et al., 2006), which may relate to more positive attitudes towards walking.

Cognitive processing of risky environments may be influenced by traits that are more narrowly defined than the Big Five. Sensation seekers seem to have an overall higher tolerance for risk (see Zuckerman, 2006 for a review). These individuals may engage in more risky behaviors and as such, may be more accepting of these behaviors in others. Other personality constructs, such as vulnerability to cognitive failures and chronic sleep disturbance, may threaten the individual's sense of personal competence in dealing with risk, and perhaps generate more negative appraisals of dangerous intersections, and avoidance coping. Traits of this kind may also increase distractibility, perhaps changing perceptions of distracted drivers.

**Role of driving-related traits.** Thus far, it has been argued that general personality traits may bias the key processes that shape appraisals of walking in general, and crosswalks in particular. Another perspective is that pedestrians are typically also vehicle drivers, and their cognitive-affective reactions to vehicle operation may also color their appraisals of walking. Perhaps an aggressive driver will be more accepting of the aggressive behaviors of other drivers when walking, for example. Matthews (2002) has proposed that there are dimensions of 'driver personality' that are somewhat detached from general personality.

The Driver Stress Inventory (DSI, Matthews, Desmond, Joyner, & Carcary, 1997) was specifically developed to assess five stable traits associated with driving: aggression, dislike of

driving, hazard monitoring, fatigue proneness, and thrill seeking. Similar trait dimensions of driving have been found in Finnish (Lajunen & Summala, 1995) and Japanese (Matthews, Tsuda, Xin, & Ozeki, 1999) samples, indicating the robustness of these traits cross-culturally. The five traits measured by the DSI have been shown to be more predictive of driver stress and performance than are more traditional measures of personality (e.g., Dorn & Matthews, 1995). Furthermore, the traits are related to different patterns of subjective and behavioral outcomes in simulator and field studies.

**Aims of Present Study**

The general aim of the study was to test a methodology for investigating pedestrians' perceptions of crosswalks that might be used by human factors practitioners. When traffic engineers assess the level of service (LOS) of a pedestrian facility, such as a crosswalk, the ultimate goal is to determine an overall letter grade for that facility. When determining LOS it is typical to examine the number of pedestrians using a walkway, the overall condition of the walkway, crossing delays, and pedestrian amenities (Landis, Vattikuti, Ottenberg, McLeod, & Guttenplan, 2001). As stated earlier, when calculating pedestrian LOS the opinions of the pedestrians are traditionally not included in the calculation. Petritsch et al. (2005) did incorporate pedestrian opinions into the level of service model. Pedestrians in this study were asked to rate the perceived safety of an intersection as well as its operational characteristics. However, Petritsch et al. (2005) specifically instructed pedestrians not to consider any characteristics (e.g. driver speed or intersection geometry) not related to the actual operational characteristics of the crossing. Using this method it would be possible for pedestrians to rate an intersection highly but for pedestrians to still find other characteristics of the intersection, that may ultimately impact walking choices, unsafe.

As previously discussed, integrating concepts from the Component Process Model and the Theory of Planned Behavior allows a multi-faceted view of pedestrians' decisions to walk and their determinations of an area's walkability. Identification of key concepts may enable researchers and traffic engineers to take into account pedestrians' feelings when determining walkability. This process in turn may lead to more walkable neighborhoods and safety countermeasures that not only reduce crashes but also increase pedestrian walking behavior. The study aimed to demonstrate the utility of the key concepts by showing that they were systematically influenced by manipulations of intersection and driver types, consistent with CPM and TPB.

Specifically, the study aimed to investigate factors influencing pedestrians' evaluations of crosswalks, within the theoretical frameworks of CPM and TPB. It focused on comparing the influences of the intrinsic level of threat of the intersection (e.g., fast vs. slow traffic) and of different categories of driver behavior (distracted, aggressive, and courteous) on pedestrian appraisals. Previous research of this nature has focused on the driver's perception of how pedestrians may evaluate a behavior (e.g., Sarkar & Andreas, 2004) but currently there is no known study examining the pedestrians' perception of these behaviors. Understanding the impact of driver/driving behaviors on pedestrians and how they influence their decisions to walk is a necessary prerequisite to the development of countermeasures and ultimately to the increase in pedestrian safety and reduction in fatalities. Thus, a new questionnaire was developed to assess pedestrians' appraisals of specific crosswalks, presented as still images, including their evaluations of the effectiveness of safety countermeasures. The study also aimed to investigate whether perceptions were biased by general and driver-related personality traits.

**Specific Predictions**

As the first of its kind, this study was exploratory in nature. However, some tentative predictions were advanced, as follows:

Four categories of appraisal - safety of the intersection, safety of drivers, controllability, and conformity to social norms – were identified as likely to shape pedestrian perceptions. It was expected that they would be differentially sensitive to the experimental manipulations of crosswalk characteristics. Because safety pertains primarily to physical characteristics of the crosswalk environment (including vehicle dynamics), intersection threat should have a stronger impact than driver behavior on safety appraisal of the intersection. As threat increases the appraisal of safety of the intersection will decrease. Possibly, aggressive and distracted driver behaviors would also decrease perceptions of safety. Conversely, appraisals of driver behavior as dangerous should be more sensitive to the driver behavior manipulation than the intersection threat manipulation. Perceived level of conformity to social norms should also be more sensitive to manipulations of driver behavior than to manipulations of intersection threat, given that dangerous driving behavior violates social norms. No prediction was made for controllability, because the pedestrian's sense of control might be influenced both by inability to influence the physical characteristics of the crosswalk and inability to affect driver behavior.

It was expected that intersection threat should have its strongest effects on countermeasures that refer to changing the physical environment, including design solutions, and possibly increasing control. Driver behavior should influence perceptions of education and enforcement, interventions that focus on the driver rather than crosswalk design. Furthermore, it was anticipated that educational and enforcement countermeasures would be rated highest for aggressive and distracted drivers.

Because of the lack of prior research, predicted effects of personality were tentative. However, two broad issues were explored. The first is the extent to which general personality factors or driving-specific traits were more predictive of pedestrian perceptions. If broad traits, such as those of the Big Five, influence appraisal and coping across a range of contexts (Matthews et al., 2009), they may also bias cognitive processes in pedestrians. For example, those high in agreeableness should rate the violation of social norms in aggressive and distracted drivers as more threatening. These individuals may look for the best in all and feel more strongly about violations from commonly held norms of behaviors. Similarly, conscientiousness might relate to beliefs in the effectiveness of increasing control as a countermeasure. Alternatively, perceptions might be more dependent on beliefs that are specific to the driving context. The DSI provides a measure of relevant traits, which might also predict the attitudes of pedestrians. Perhaps those drivers who are threat-sensitive within the driving context (high dislike of driving) also find crossing the street more threatening.

A second issue is the extent to which cognition is guided by pedestrians feeling a sympathy or rapport with drivers whose behaviors are consistent with their own. That is, they may view their own driving behaviors as safe and controlled, and therefore may feel that drivers with similar characteristics also are operating safely and within their own control. For example, pedestrians who are high in driver aggression might view aggressive drivers as safer. Likewise, those participants reporting high cognitive failures might perceive distracted drivers as safer, because it is assumed that distractibility is normal.

# CHAPTER 2

## Method

### Participants

A total of 268 students from the University of Cincinnati (82 men, 186 women) participated in the study in order to fulfill a course requirement. Participants ranged in age from 18 to 46 ($M$ = 19.82 years, $SD$ =3.41). All participants had a valid driver's license for a mean duration of 3.59 years ($SD$ = 2.98, range: <1 – 25 years). Participants' annual driving was reported as: less than 5,000 miles, 21.6%; 5,000 – 10,000 miles, 41.4%; 10,000 to 15,000 miles, 16.0%; 15,000 – 20,000 miles, 12.3%; greater than 20,000 miles, 8.6%. Participants driving frequency was reported as: everyday, 43.3%; 2-3 days per week, 22.0; once per week, 7.5%; less than once per week, 27.2%.

Participants spent an average of 11.48 hours per week walking ($SD$ = 10.24, range 0 – 50) and took an average of 4.84 walks per week ($SD$ = 4.42, range 0 – 40). Participants also indicated the types of walks took in the past week. The percentage of participants engaging in each walking type is identified in Appendix A. All participants were treated in an ethical manner and were free to withdraw from the study at any time without penalty (American Psychological Association, 2010).

### Design and Materials

A within groups design was used. Factors were intersection threat and driving behavior. Three intersection types were examined: (1) Two lane road (two-way traffic) with 25 MPH speed limit; (2) Four lane road (two-way traffic) with 35 MPH speed limit; (3) Four lane road with median (two-way traffic) with 45 MPH speed limit. The intersection types were chosen based on their common occurrence in urban, suburban, and rural areas throughout the United States of America. The three speeds were chosen as these are the most common speeds for local roads and arterials

throughout the USA. Furthermore, 25 MPH is the maximum speed at which a pedestrian can be struck by a vehicle with a high probability (>80%) of survival.

The three driver behavior types examined were: (1) aggressive driving behaviors; (2) distracted driving behaviors; and (3) safe driving behaviors. Aggressive driving behaviors were chosen as these are known to be safety hazards. Distracted driving behaviors were chosen because they have been cited as an increasingly serious safety problem on roadways (LaHood, 2010b).

**Roadway scenario packet.** The three driver behavior types and three intersection types were combined to create nine roadway scenarios. Intersection images from nine intersections (three 2 lane, three 4 lane, and three 4 lane with median) were taken from the Washington, DC area using Google Earth images (Google Inc., 2009). Intersection images and their respective locations along with the behavioral descriptions can be found in Appendix B. Images were taken from the Washington, DC area to minimize the likelihood that the University of Cincinnati participants would be familiar with the intersections depicted. Three intersection groups were created from the images. Each intersection group contained one images from each of the intersection types. These intersection groups were then randomized across driver behavior types. The order of presentation of driver behavior types was also randomized. This created six different roadway scenario packets. Participants were randomly given one of the six different roadway scenario packets.

**Questionnaires.** All questionnaires can be found in Appendix C.

*Driver Stress Vulnerability (DSI, DCQ).* The DSI (Matthews et al., 1997) is an experimentally validated questionnaire that assesses the driver's susceptibility to stress reactions including anxiety and aggression, and the attitudes that may underpin stress response, such as concerns about safety. It also assesses the driver's typical style of coping with stress. The DSI is

divided into two sections. Participants first complete the 12 item first section. This section assess attributes of driving including years licensed to drive, typical number of days driven in a week, typical road types traveled on, number of miles driven annually, and number and type of major and minor accidents in the past three years. Section B contains 41 items designed to assess thrill seeking, aggression, dislike of driving, hazard monitoring, and fatigue proneness. The Driver Coping Questionnaire (DCQ) is a 35 item measure that assesses driver's coping strategies. It asks the driver to report the strategies used to deal with driving when it becomes "difficult, stressful or upsetting". The DCQ assesses confrontive coping, emotion-focus, task-focus, avoidance, and reappraisal. (Data from the DCQ were not analyzed for this dissertation.)

*Mini-Modular Markers.* The 40-item Mini-Modular Markers (3M40; Saucier, 2003) scale assesses the Big Five personality traits as orthogonal dimensions: Openness (Intellect), Conscientiousness, Extraversion, Agreeableness, and Neuroticism. This is a new Big Five marker set that is shown to have markedly lower interscale correlation, with no loss of validity, relative to previous marker sets with comparable number of items (Saucier, 2003).

*Road Rage.* The eight-item road rage questionnaire is a shortened and modified version of the National Road Rage Survey (AutoVantage, 2008). The National Road Rage Survey is a 34 item questionnaire that assesses drivers' perceptions of the courtesy and driving habits of other drivers in their metropolitan area, their opinions as to how drivers in their area compare to other drivers, and their perceptions of their own driving habits. Only those items related to the courtesy, distraction, and aggression of other drivers were assessed in the modified version of the questionnaire. (Data from the survey were not analyzed for this dissertation.)

*Specific personality traits*. Items in this questionnaire assess personality factors related to individual differences in attitudes and behaviors related to risk, including cognitive failures, chronic

sleep disturbance, and sensation seeking. This questionnaire is based on a factor analysis of a larger set of personality instruments within this domain (Shaw et al., 2010).

*Short Dundee Stress State Questionnaire.* The 30-item short Dundee Stress State Questionnaire (DSSQ: Matthews, Emo, & Funke, 2005) assesses three forms of stress response: task disengagement, distress and worry. The 30 item questionnaire is based upon the 96-item Dundee Stress State Questionnaire (DSSQ: Matthews et al., 1999). The DSSQ was designed specifically to reflect the multidimensionality of stress states. (It was used here to monitor affective state during the study, but data from the DSSQ were not analyzed for this dissertation.)

*Pedestrian Perspectives Questionnaire*. The experimenter created an unpublished pilot Pedestrian Perspectives Questionnaire (PPQ), on the basis of the conceptual analysis of categories of perception previously described. It is a 38-item measure separated into three sections. Section one assesses how these different driver behaviors impact pedestrians' feelings of comfort and safety at an intersection. The intersection characteristics section of the questionnaire assesses a pedestrian's opinions of the relative safety or threat of a given intersection. It was anticipated that items in this section would provide insight into the types of roadways pedestrians find threatening and those they perceive to be safe. Additionally it was anticipated that these questions would provide information regarding the pedestrian's viewpoint of the level of service (LOS) of a given pedestrian facility.

Questions in this section included items such as "I would rate this as a safe intersection", "This area would be a good place to cross the road", and "I would feel comfortable crossing here without a marked crosswalk".

Section two of the questionnaire assesses how these behaviors impact pedestrians' feelings of intrinsic pleasantness, coping and perceived control, and their compatibility with social norms. These items were designed to determine how behaviors of drivers, independent of roadway

characteristics, influence pedestrians' feelings of safety and desire to walk in an area. Furthermore, these questions were designed using the framework of both the Component Process Model (Scherer, 2001) and the Theory of Planned Behavior (Ajzen, 1988, 1991). Items in this section were designed specifically to assess TPB subjective norms and CPM normative significance, TPB attitude toward behavior and CPM implications, and TPM perceived control and CPM Coping potential. No items specifically related only to CPM goal relevance (Scherer, 2001). It was determined these items should be excluded from the PPQ as in the context of this study CPM goal relevance was related both to pleasantness and coping. Questions in this section included items such as "This behavior would make me feel uneasy", "This behavior is acceptable at this type of intersection", and "I would be confident drivers would do nothing to threaten my safety".

The third and final section of the questionnaire contains items relating to pedestrian safety countermeasures. These items were used to determine pedestrians' opinions of the efficacy of various countermeasures in increasing pedestrian safety based on a given intersection and set of driver behaviors. This section contained items designed to assess how different pedestrian countermeasures would impact the pedestrians' feelings of intrinsic pleasantness, coping and perceived control, and their compatibility with social norms. Ultimately, the goal of this section was to assess the efficacy of countermeasure interventions to increase walking behavior. This section included such items as "Increase the visibility of crosswalks", "Create more pedestrian boulevards that prohibit automobile traffic", and "Create bulb outs in sidewalks to decrease the distance that a pedestrian needs to be in the roadway". Design items were concerned specifically with changes to the infrastructure. Control items were concerned with increasing pedestrians' feelings of control of the crossing situation. Items such as "Have pedestrian actuated barriers similar to railroad crossings, to protect pedestrians" were control countermeasures. It many cases, such as the previous example,

these countermeasures may not be practical for wide scale installation. However, the intent behind these items was to determine the types of countermeasures pedestrians found desirable given a specific intersection and behavior type – and not the cost or practicality of installing such a countermeasure. Enforcement items assessed the perceived efficacy of increased fines and penalties associated with violating pedestrian safety. Lastly, education items were concerned with the perceived efficacy of increased driver awareness about pedestrians and pedestrian safety.

The PPQ was constructed to assess four constructs related to perceptions of intersection crossing safety, and four related to evaluations of countermeasures. Thus, data from the following 8 item sets were available for each intersection.

| Category | Item set | # of items |
|---|---|---|
| Perceptions | | |
| | Appraisals of safety | 6 |
| | Appraisals of driver threat | 3 |
| | Control beliefs | 5 |
| | Social norms | 4 |
| Countermeasures | | |
| | Roadway design | 8 |
| | Control and coping | 4 |
| | Enforcement | 4 |
| | Education | 4 |

Originally, both the enforcement and education item sets were part of a larger social norms set. However, preliminary data analyses saw these emerge as two distinct items sets.

In sum, the Pedestrian Perspectives questionnaire was designed to assess pedestrians' opinions of intersection threat and driver behaviors as they relate to the walkability of an intersection. Additionally it was designed to assess respondents' opinions of the efficacy of different roadway countermeasures, driver education methods, and targeted regulation enforcement as they relate to the different driver behaviors and intersections.

**Questionnaire packets.** The seven questionnaires were assembled into one packet. The questionnaires were presented in the same order for all participants: demographic information, Driver Stress Vulnerability, Mini-Modular Markers, Road Rage, Personality, pre-task Short Dundee Stress State Questionnaire, Pedestrian Perspectives Questionnaire (for each of nine scenarios), and post-task Short Dundee Stress State Questionnaire.

## General Procedure

Participants were tested in groups in a classroom setting where no classes were currently scheduled. During the experimental session the experimenter was seated in the back of the room to minimize distractions.

Upon arriving at the experimental session individuals were first given an informed consent form. They were instructed to read the form and encouraged to ask any questions about the form or study prior to providing their signed consent to participate. After providing consent to participate each participant was given a questionnaire packet and roadway scenario packet. The questionnaire packets were identical for all participants. However, there were six different roadway scenario packets. The presentation of the driver behaviors and the intersection photographs associated with each behavior were randomized across the six packets.

Participants were informed that the entire study was questionnaire based. They were told that after receiving general instructions from the experimenter they would complete the questionnaire packet at their own pace. Participants were advised that the duration of the study would not exceed 90 minutes.

Participants were informed that the purpose of the study was to determine their opinions as pedestrians about different driver behaviors, roadway geometries, and pedestrian safety

countermeasures. They were told that they would first complete some basic demographic information followed by personality, driving behavior, and road rage questionnaires. Participants were then given instruction regarding the pedestrian perspectives portion of the questionnaire packet. Participants were informed that when they reached the first Pedestrian Perspectives Questionnaire they were to consult the first scenario in their driver scenario packet. They were told that they should base their answers to the questions in the first Pedestrian Perspectives Questionnaire on the first roadway scene and driver behavior combination depicted in their packet. They were told that they would fill out the one-page Pedestrian Perspectives Questionnaire nine times: one time for each roadway scene and driver behavior combination in the roadway scenario packet. To reduce confusion, since they would be completing the same questionnaire nine times, participants were advised that the instructions for each Pedestrian Perspectives Questionnaire indicated a scenario number (1-9) on which to base their answers and would correspond to a scenario/behavior page number.

Participants were then given an example roadway scenario. The experimenter reviewed the roadway scenario with the participants. Participants were instructed that they should imagine what it would be like crossing the street depicted given the speed limit and driver behaviors described. Participants were told that in each scenario the red arrow in the photograph indicated the intersection they were to imagine crossing and the direction of the crossing maneuver. The experimenter then read aloud the example behavior description and told participants that each scenario would be different and that they should base their answers to each Pedestrian Perspectives Questionnaire on only the corresponding scenario/behavior combination. Participants were instructed that they could view each scenario for an unlimited period of time and should fill out the corresponding questionnaire only when they felt they had a good

understanding of what it would be like to cross at the depicted intersection. Participants were then given an opportunity to ask any questions about the task and were instructed that they would be able to ask questions at any time during the experimental session. Participants then began completing the self-paced questionnaire packets.

# CHAPTER 3

## Results

### Pedestrian Perceptions: Scale Development

As described in the method, each intersection scenario was rated with respect to 38 questions, divided into eight categories or constructs. We checked the internal consistency (reliability) of each of the eight item sets for each of the nine scenarios. Alpha coefficients were uniformly acceptable (>.80), exceeding 0.9 in most cases. Thus, scale scores corresponding to each of the eight constructs were computed by summating item scores. Scale values were computed for each of the nine scenarios. That is, there were a total of 72 scales (eight perception/countermeasure variables x nine scenarios). These scales were used as the dependent variables for the analyses of effects of intersection safety and driver type on pedestrian perceptions. Further analyses, described below, were subsequently conducted to reduce these variables to a smaller number for analyses of individual differences in perception.

### Effects of Intersection Safety and Driver Threat on Pedestrian Perceptions

Analyses were conducted to test the effects of intersection safety and driver threat on the four perception variables from the Pedestrian Perspectives Questionnaire. First, some qualitative features of these data are described, prior to analysis. The mean values for the four conceptual categories of appraisal are shown in Figure 1, as a function of driver behavior. (Error bars are standard errors, in all figures.) Mean levels of appraisal variables for each level of intersection safety are shown in Figure 2. The complete table of means and standard deviations may be found in Appendix D.

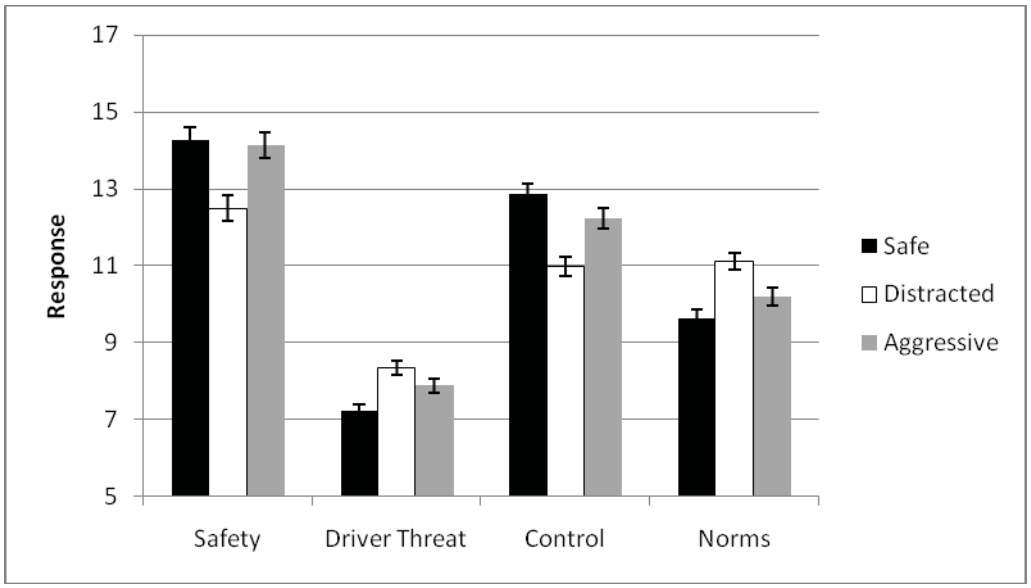



*Figure 1.* Mean values of safety appraisal for the three behavior variables.

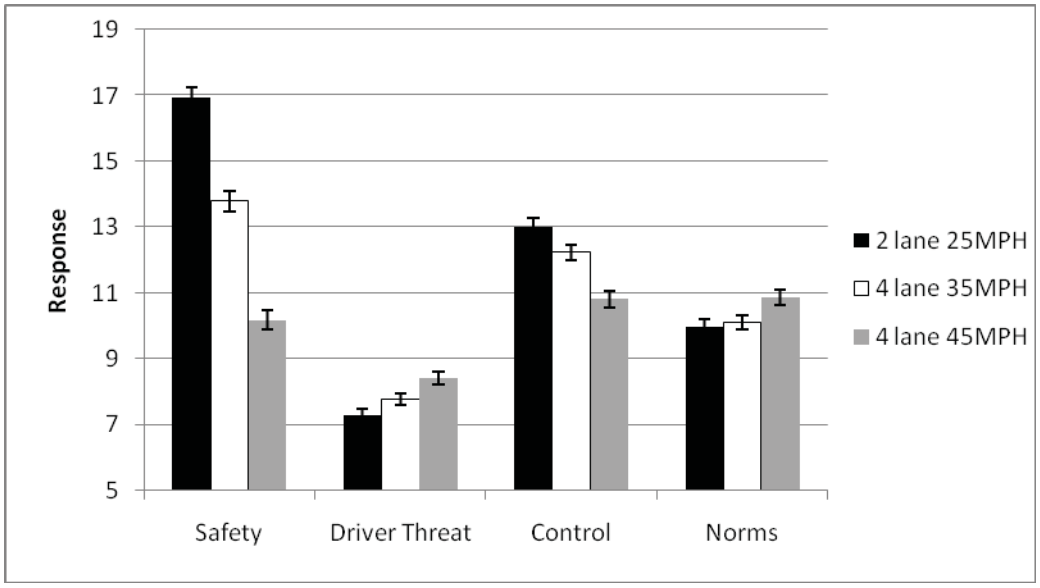



*Figure 2.* Mean levels of safety appraisal for the three intersection threat variables.

Figure 2 suggests that pedestrians tend to view distracted driving behaviors as more dangerous and threatening to crossing behaviors than safe or aggressive behaviors. The distracted driver condition had the highest means for driver threat and for lack of conformity with social norms.

As expected, pedestrians tend to view intersections with fewer lanes and slower drivers as safer. They also report decreased feelings of threat at lower speeds and increased feelings of personal control. Figure 3 suggests that intersection threat especially impacted perceptions of safety.

Repeated measures analyses of variance (ANOVAs) to test the effects on the perception variables of each of the four perception categories (safety appraisal, perceived driver threat, perceived control, and conformity to social norms). The results of these ANOVAs are summarized in Table 1.

| Perception ANOVAs | | | | | |
|---|---|---|---|---|---|
| | | df | *F* | partial $\eta^2$ | *p* |
| Safety Appraisal | Behavior | 2, 244 | 4.397 | 0.035 | <.01 |
| | Threat | 2, 244 | 173.723 | 0.587 | <.01 |
| | Interaction | 2, 242 | 1.72 | 0.028 | ns |
| | | | | | |
| Perceived Driver Threat | Behavior | 2, 260 | 2.718 | 0.02 | ns |
| | Threat | 2, 260 | 50.505 | 0.28 | <.01 |
| | Interaction | 2, 258 | 3.28 | 0.048 | <.01 |
| | | | | | |
| Control | Behavior | 2, 226 | 2.821 | 0.024 | ns |
| | Threat | 2, 226 | 57.064 | 0.336 | <.01 |
| | Interaction | 2, 244 | 1.428 | 0.025 | ns |
| | | | | | |
| Social Norms | Behavior | 2, 238 | 3.321 | 0.027 | <.05 |
| | Threat | 2, 238 | 22.143 | 0.157 | <.01 |
| | Interaction | 2, 236 | 0.43 | 0.007 | ns |

*Table 1.* ANOVAs of safety appraisals of intersection and behavior variables.

From the ANOVAs it appears that overall intersection threat is a stronger influence on pedestrian perceptions than driver behavior, as indicated by larger effect sizes for intersection threat. Pedestrian perceptions seem to be more impacted by driver speed and overall intersection configuration than by driver behavior. However, there are some small effect sizes observed for behaviors. Specifically, for safety appraisal a significant main effect is observed for both

behavior and threat ($F(2, 224) = 4.397$, $p<.01$; $F(2, 224) = 173.723$, $p<.01$, respectively) whereby pedestrians feel the least safe in the presence of distracted drivers and most threatened at intersections with the highest speed and most lanes. Perceived threat shows a main effect for driver threat appraisal ($F$ (2, 260) = 50.505, $p<.01$) whereby as speed and lane numbers increase so do feelings of threat. As shown in Figure 3, a small behavior x threat interaction ($F$ (2, 258) = 3.28, $p<.01$) is also observed for perceived threat. This interaction shows the effect of the highest speed on driver threat is especially high for distracted and aggressive drivers. Main effects of threat are shown for both control and social norms ($F$ (2, 226) = 57.064, $p<.01$; $F$ (2, 238) = 22.143, $p<.01$, respectively). Respondents report less control and increased violation of social norms as speed and number of lanes increase. Lastly, a small main effect for behavior is shown for social norms ($F$ (2, 238) = 3.321, $p<.05$) indicating that distracted drivers are the highest violators of these norms. Overall, the largest effect of threat is on appraisal and the smallest is on social norms with the effect of threat falling in the middle of the spectrum for both perceived threat and control.

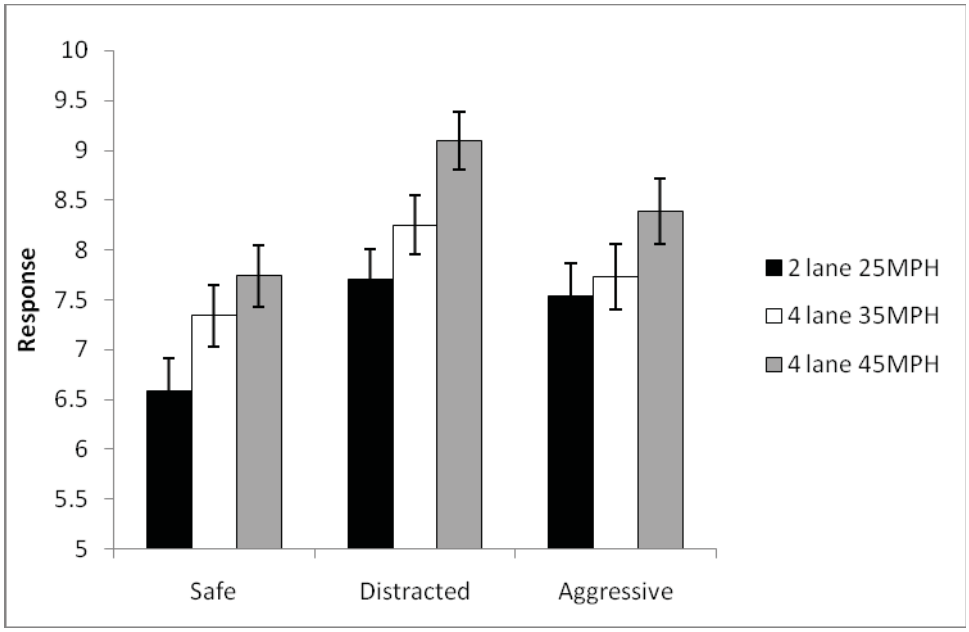



*Figure 3.* Behavior x Intersection threat appraisal interaction.

**Countermeasure Efficacy Descriptive Statistics**

Means and standard deviations for the 20 countermeasure treatment items in the Pedestrian Perspectives Questionnaire were calculated (see Table 2). The complete table of means and standard deviations is found in Appendix E. Respondents rated the countermeasure "Reward good driving behaviors with an incentive program such as discounts on auto insurance" highest ($M = 3.51$, $SD = 1.46$). The second highest overall rated countermeasure was "Increase the visibility of crosswalks" ($M = 3.36$ $SD = 1.34$). The three lowest rated countermeasures were "Have call boxes at crosswalks so that drivers who intimidate pedestrians can be reported to law enforcement" ($M = 2.21$ $SD = 1.55$), "Have pedestrian actuated barriers, similar to railroad crossings, to protect pedestrians" ($M = 2.35$ $SD = 1.57$), and "Allow pedestrians to adjust the length of a traffic signal to allow more time for crossing if needed" ($M = 2.44$, $SD = 1.59$), respectively.

| Countermeasure | Overall *M* | Overall *SD* | Conceptual Category |
|---|---|---|---|
| Reward good driving behaviors with an incentive program such as discounts on auto insurance. | 3.51 | 1.46 | Education |
| Increase the visibility of crosswalks | 3.36 | 1.34 | Control |
| Give drivers more advance warning of crosswalks | 3.14 | 1.35 | Control |
| Create more frequent safe crossings on busy streets | 3.06 | 1.47 | Control |
| Design crosswalks to increase the distance between vehicles and pedestrians | 2.99 | 1.55 | Design |
| Create pedestrian overpasses to eliminate pedestrian delay and enhance safety | 2.98 | 1.69 | Design |
| Have refuge islands in the middle of roadways with 4 or more lanes | 2.95 | 1.61 | Design |
| Increase penalties for violations in the vicinity of crosswalks | 2.85 | 1.51 | Enforcement |
| Place speed humps close to crosswalks in order to slow traffic | 2.81 | 1.52 | Design |
| Educate drivers in safer driving at crosswalks | 2.80 | 1.53 | Education |
| Use cameras to detect violations in the vicinity of crosswalks | 2.80 | 1.56 | Enforcement |
| Increase traffic law enforcement in the vicinity of crosswalks | 2.77 | 1.52 | Enforcement |
| Lower speed limits in the vicinity of crosswalks | 2.71 | 1.55 | Design |
| Increase signal cycle times to reduce the time pedestrians have to wait to cross the road | 2.68 | 1.48 | Design |
| Create more pedestrian boulevards that prohibit automobile traffic | 2.62 | 1.55 | Design |
| Create bulb outs in sidewalks to decrease the distance that a pedestrian needs to be in the roadway | 2.52 | 1.55 | Design |
| Implement a public awareness campaign that explains appropriate crosswalk behaviors for both drivers and pedestrians | 2.50 | 1.58 | Education |
| Allow pedestrians to adjust the length of a traffic signal to allow more time for crossing if needed | 2.44 | 1.59 | Control |
| Have pedestrian actuated barriers, similar to railroad crossings, to protect pedestrians | 2.35 | 1.57 | Control |
| Have call boxes at crosswalks so that drivers who intimidate pedestrians can be reported to law enforcement | 2.21 | 1.55 | Enforcement |

*Table 2. Overall ratings of countermeasure efficacy.*

**Effects of Intersection Safety and Driver Threat on Perceptions of Countermeasures**

Analyses were next conducted on the countermeasure variables. The mean values for the behavior variables across the four conceptual categories are shown in Figure 4. Mean values for threat variables across the four conceptual categories are shown in Figure 5.

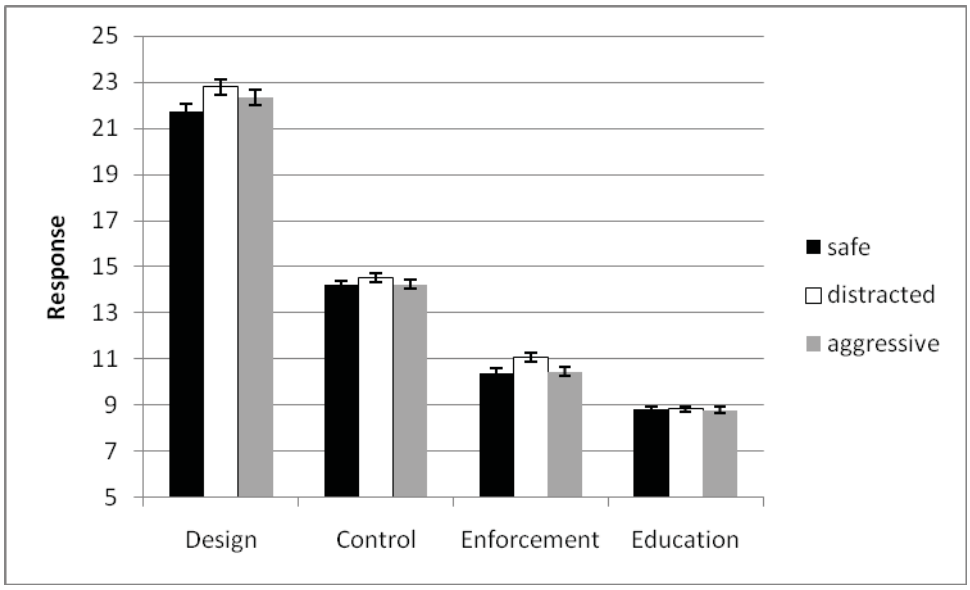



*Figure 4.* Mean values of countermeasure efficacy for the three behavior variables.

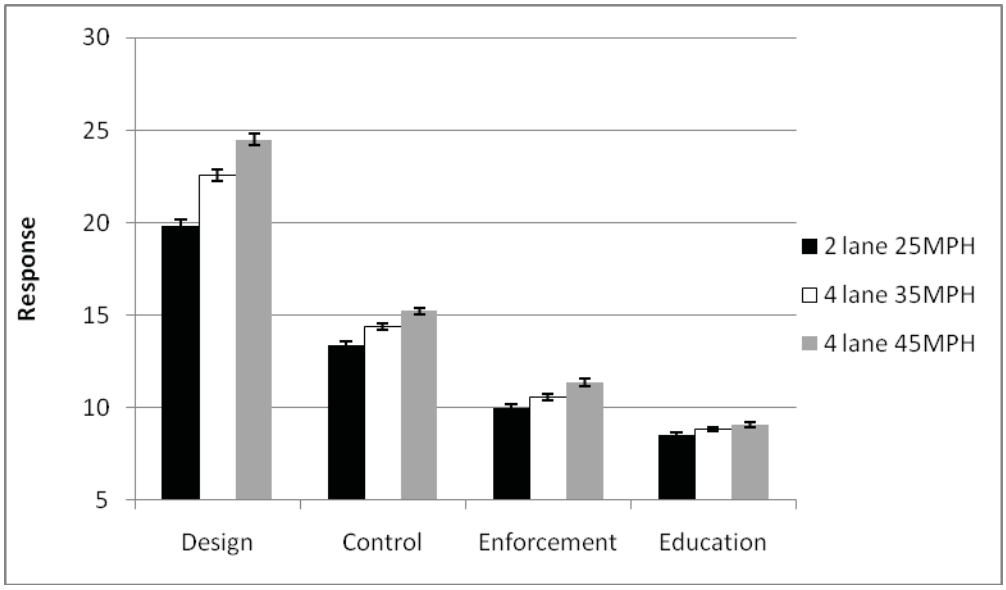



*Figure 5.* Mean values of countermeasure efficacy for the three intersection threat variables.

As shown in the figures, there is an overall observed trend that speed and intersection threat is the major influence on driver perceptions. Overall, at lower speeds, pedestrians are rating countermeasures as less effective, with the exception being enforcement countermeasures. This finding could be the result of pedestrians having an optimistic view of the efficacy of countermeasures at more threatening intersections. That is, at lower speeds pedestrians may feel confident of crossing in comfort and therefore feel countermeasures are unnecessary. However, at greater speeds when pedestrians do find countermeasures to be necessary they believe the countermeasures selected will be highly effective.

Repeated measures ANOVAs were conducted to test the effect on the countermeasure efficacy variables of each of the four conceptual categories (design, perceived control, enforcement, and education). The results of these ANOVAs are summarized in Table 3.

| Countermeasure ANOVAs | | | | | |
|---|---|---|---|---|---|
| | | df | *F* | partial $\eta^2$ | *p* |
| Design | Behavior | 2, 198 | 1.61 | 0.016 | ns |
| | Threat | 2, 198 | 70.195 | 0.415 | <.01 |
| | Interaction | 2, 196 | 1.278 | 0.025 | ns |
| | | | | | |
| Control | Behavior | 2, 224 | 0.602 | 0.005 | ns |
| | Threat | 2, 224 | 38.906 | 0.258 | <.01 |
| | Interaction | 2, 222 | 7.199 | 0.115 | <.01 |
| | | | | | |
| Enforcement | Behavior | 2, 236 | 3.295 | 0.027 | <.05 |
| | Threat | 2, 236 | 39.527 | 0.251 | <.01 |
| | Interaction | 2, 234 | 0.277 | 0.005 | ns |
| | | | | | |
| Education | Behavior | 2, 254 | 0.292 | 0.002 | ns |
| | Threat | 2, 254 | 17.358 | 0.12 | <.01 |
| | Interaction | 2, 252 | 0.597 | 0.009 | ns |

*Table 3.* ANOVAs of countermeasure efficacy of intersection and behavior variables.

As with the perception ANOVAs, it appears that intersection threat is a stronger influence on pedestrian perspectives of countermeasure efficacy than is driver behavior, as shown by the effect sizes for main effects. Overall, pedestrians seem to report greater efficacy for countermeasures at higher speeds. In three out of four analyses, the threat x driver behavior interaction was nonsignificant, implying that the countermeasure types is seen as equally effective whatever the style of behavior exhibited by drivers.

A main effect of threat is shown for all four countermeasure categories (Design: $F$ (2, 198) = 70.195, $p$<.01; Control: $F$ (2, 224) = 38.906, $p$<.01; Enforcement: $F$ (2, 236) = 39.527, $p$<.01; Education: $F$ (2, 236) = 17.358, $p$<.01) indicating that as threat increases so does respondents' opinions of the efficacy of countermeasure treatments. A significant threat x behavior interaction was observed for control ($F$ (2, 222) = 7.199, $p$<.01), as shown in figure 6, indicating control countermeasures influence perceived effectiveness only at the lowest speed. Interactions were not observed for the other countermeasure categories. Lastly, a modest main effect of behavior was found for enforcement ($F$ (2, 236) = 3.295, $p$<.05) indicating that distracted drivers would most benefit from enforcement countermeasures. The largest main effect of threat is on design and the lowest is observed for education with effect sizes for enforcement and control effects falling in the middle of these effects.

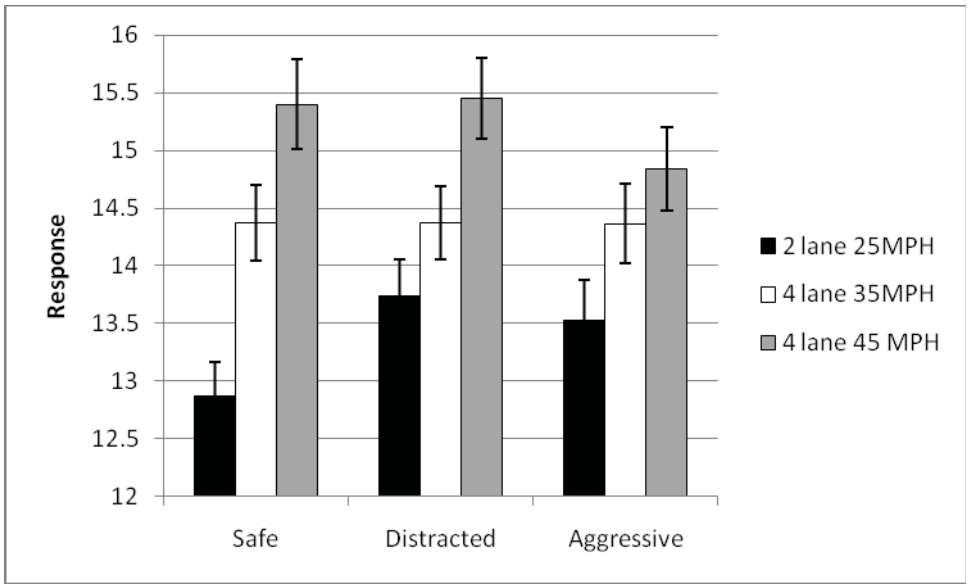



*Figure 6.* Behavior x Intersection countermeasure efficacy interaction.

**Individual Differences: Factor Analyses of Pedestrian Perceptions**

Whereas the ANOVAs were based on the seven conceptually-defined categories of pedestrian perception, correlational analyses were based on a factor analysis that aimed to provide a simpler dimensional model of individual differences. The conceptually-defined scales were intercorrelated, and so factor analysis was used to reduce them to a more manageable set for use as criteria in correlational and regression analyses. In principle, there are several different dimensions along which individual differences in perceptions of intersections may be organized. First, perceptions might be structured by the conceptual categories. In this case we might have one factor defined by appraisals of safety across all scenarios, a second factor defined by appraisals of driver threat, and so on. Second, factor structure might reflect speed, with three dimensions defined by the different levels of threat associated with the three different driver speeds. For example, perhaps some individuals are especially concerned with the dangers of crossing higher-speed roads. Third, dimensional structure might reflect the three driver types;

perhaps people differ in their perceptions of the threat posed by aggressive and distracted drivers. More complex factor structures organized around combinations of conceptual categories, speed and driver type are also possible.

Separate exploratory factor analyses were run for the perception and countermeasure variable sets. An initial principal axis factor solution was extracted, and then rotated using the direct oblimin criterion, which allows factors to be correlated in order to improve the approximation to simple structure. In each case, the scree test (Cattell, 1973) was used to determine the optimal number of factors to be extracted. Because the test provides a guideline rather than a definitive number, factor solutions of the number indicated by the scree test ± 1 were also examined, and factor interpretability was used to make a final decision.

For the perception variables, three factors were extracted (see Appendix F for factor pattern matrix), explaining 69.7% of the variance. Factor correlations ranged from .35 - .46. Each factor corresponded to one of the driver types. Thus, individual differences in perception appeared to reflect primarily level of concern about safe drivers, concerns about distracted drivers and concerns about aggressive drivers. In the factor analysis of countermeasure variables, four factors were extracted, explaining 75.3% of the variance. Range of factor correlations was .29 - .42. Again, three factors corresponding to driver types were found, together with a fourth factor defined by the driver education scales. Thus, in general, the effectiveness of countermeasures is rated in relation to different groups of drivers, but evaluations of education are not linked to any specific driver type.

On this basis, seven scales were constructed for use in the correlational analyses. For example, ‘perceptions of safe drivers’ was assessed as the sum of the twelve scales (four

perception variables x 3 speeds) defining the relevant factor. All scales had high internal consistency (reliability), and are summarized in Table 4.

| Category | Item set | # of scales | α |
|---|---|---|---|
| Perceptions | | | |
| | Perceptions of safe drivers | 12 | .964 |
| | Perceptions of distracted drivers | 12 | .953 |
| | Perceptions of aggressive drivers | 12 | .967 |
| Countermeasures | | | |
| | Effectiveness for safe drivers | 9 | .940 |
| | Effectiveness for distracted drivers | 9 | .935 |
| | Effectiveness for aggressive drivers | 9 | .954 |
| | Effectiveness of education | 9 | .959 |

*Table 4.* Reliability of the seven scales.

**Correlations between Pedestrian Perception Factors and Personality**

A table of correlations between the seven pedestrian perception and countermeasures factors and the DSI/DCQ variables, big 5 personality variables, specific personality variables, and pre and post task DSSQ variables can be found in Appendix G. Because of the number of predictors available, the primary means of data analysis was multiple regression.

| | | Countermeasure Efficacy | | | |
|---|---|---|---|---|---|
| Safety Appraisal | | Safe | Distracted | Aggressive | Education |
| | Safe | -0.515** | 0.141 | -0.029 | -0.013 |
| | Distracted | 0.162* | -0.339** | 0.143* | -0.005 |
| | Aggressive | 0.118 | -0.059 | -0.468** | -0.153* |
| *Note: * p<.05, ** p <.01* | | | | | |

*Table 5. Correlations between safety appraisal and countermeasure efficacy factors.*

Correlations between the three safety appraisal factors and four countermeasure efficacy factors are shown in Table 5. Each safety appraisal factor shows a significant negative correlation with the corresponding countermeasure efficacy factor. These relationships indicate that when behaviors are appraised as safe the corresponding countermeasure is rated as ineffective. It could be

that individuals feel that if the behavior is safe countermeasure treatments are unnecessary. For educational countermeasures, the only countermeasure category without a corresponding safety appraisal category, the only significant correlation is with aggressive appraisals.

| Safety Appraisals | | | |
|---|---|---|---|
| | Safe | Distracted | Aggressive |
| Safe | 1 | -0.135 | -0.379** |
| Distracted | -0.135 | 1 | -0.322** |
| Aggressive | -0.379** | -0.322** | 1 |
| *Note: ** p <.01* | | | |

*Table 6.* Correlations among the safety appraisal factors.

As shown in Table 6 some significant correlations between the safety appraisal factors were also observed. Appraisals of safe and aggressive driving behaviors were negatively correlated so if one behavior is appraised as being safe the other is appraised as being more threatening. A significant correlation is also present between aggressive and distracted driving behaviors. Again, when one is appraised as safe the other is appraised as being more threatening.

| Countermeasure Efficacy | | | | |
|---|---|---|---|---|
| | Safe | Distracted | Aggressive | Education |
| Safe | 1 | 0.470** | 0.621** | 0.404** |
| Distracted | 0.470** | 1 | 0.634** | 0.634** |
| Aggressive | 0.621** | 0.634** | 1 | 0.512** |
| Education | 0.404** | 0.634** | 0.512** | 1 |
| *Note: ** p <.01* | | | | |

*Table 7.* Correlations among the countermeasure efficacy variables.

Table 7 shows the correlations among the countermeasure efficacy variables. These variables are all positively intercorrelated. If a countermeasure is deemed as effective for one group, the same tends to hold for the other behavior groups.

Separate regressions were run for each of the pedestrian factors using general personality (Big Five), specific personality traits, and driver stress vulnerability (DSI) variables as predictors using a hierarchical method. A summary of results for the safety appraisal factors is shown in Table

8 and a summary of the results for the countermeasure factors is shown in Table 9. In each regression, the Big Five (agreeableness, openness, conscientiousness, neuroticism, and extraversion) was entered first. The second set of predictors to be entered were the specific personality variables (sensation seeking, cognitive failures, and sleep disturbances). Driver stress vulnerability types identified by the DSI (fatigue proneness, hazard monitoring, dislike of driving, thrill seeking, and aggression) were entered at the third step.

Table 8 gives summary statistics for the regressions using appraisals of safety as the criteria. The change in $R^2$ at each step is given, together with the predictors making a significant, independent contribution to the equation. (Note that degrees of freedom for error terms varied across equations because of variation in missing values). The final equation for each criterion is defined by the step at which additional predictor sets fail to add significantly to the variance explained.

There were no significant predictors of appraisals of safe drivers. However, appraisals of distracted drivers appeared to be influenced both by the Big Five, and by the driving-related traits. In the final equation, both agreeableness and DSI thrill-seeking were associated with perceiving distracted drivers as less safe. Although there were two significant Big Five predictors of appraisals of aggressive drivers at the first step of the regression, these variables were no longer predictive following entry of the specific personality traits at step two. It appeared that sensation-seeking was associated with perceiving aggressive drivers as safer. Possibly, sensation-seekers do not see aggressive behaviors as a major problem.

Table 9 shows the corresponding summary data for the regressions that used countermeasure factors as the criteria. In this case, depending on the criterion of interest, there appeared to be a role for all three of the predictor sets. Of the Big Five, conscientiousness was

one of the more prominent predictors; it related to rating countermeasures for aggression, and education as less effective. Perhaps conscientious individuals recognize their own due diligence may not translate to other groups of drivers. A similar explanation might apply to the negative associations between DSI hazard monitoring and perceptions of the effectiveness of countermeasures for safe and distracted drivers. Neuroticism was associated with negative evaluations of the effectiveness of countermeasures for distracted drivers, and negative perceptions of education. Sensation-seekers not only appraise aggressive drivers as safer (Table 8), but also appraise countermeasures for aggression as less effective. Given the negative correlation between perception of driver safety and countermeasures, sensation-seekers may not see countermeasures for aggression as important. Other personality factors that related to at least one criterion, in the final equation, were sleep disturbance and DSI aggression (both negatively related to distracted driver countermeasures), and DSI thrill-seeking (negatively related to education). In general, the results of the regression analyses indicate that pedestrian perceptions are influenced by multiple factors. No one category of personality factor seemed generally more important than the others. Indeed, many small individual biases may be working together simultaneously to shape perceptions of driver behaviors and effectiveness of countermeasures.

| Safety Appraisals | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Safe | | Distracted | | | | Aggressive | | | |
| Step | Variables entered | df 1 | df 2 | *R* | $R^2$ Change | R | $R^2$ Change | Significant Predictors | β | R | $R^2$ Change | Significant Predictors | β |
| 1 | Big Five | 5 | 222 - 212 | 0.133 | 0.018 | 0.263 | 0.069* | agreeableness | -0.197** | 0.231 | 0.053* | conscientiousness | 0.138* |
| | | | | | | | | openness | -0.150* | | | neuroticism | -0.147* |
| 2 | Specific Personality Variables | 3 | 219 - 209 | 0.176 | 0.013 | 0.314 | 0.030 | agreeableness | -0.176** | 0.303 | 0.038* | sensation seeking | 0.165* |
| | | | | | | | | sensation seeking | -0.140* | | | | |
| 3 | DSI | 5 | 214 - 204 | 0.227 | 0..020 | 0.383 | 0.094* | agreeableness | -0.231** | 0.342 | 0.025 | N/A | |
| | | | | | | | | thrill seeking | -0.158* | | | | |

*Note: * p<.05, ** p <.01*

Big Five = Agreeableness, Openness, Conscientiousness, Neuroticism, Extraversion

Specific Personality = sensation seeking, cognitive failures, sleep disturbances

DSI = fatigue proneness, hazard monitoring, dislike of driving, thrill seeking, aggression

*Table 8. Safety appraisals regressions: Summary statistics.*

| Countermeasures | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Safe | | | Distracted | | | Aggressive | | | Education | | |
| Step | Variables entered | df 1 | df 2 | *R* | $R^2$ Change | Significant Predictors | *R* | $R^2$ Change | Significant Predictors | *R* | $R^2$ Change | Significant Predictors | *R* | $R^2$ Change | Significant Predictors |
| 1 | Big Five | 5 | 236 - 198 | 0.191 | 0.036 | agreeableness (β = -.150*) | 0.301 | 0.091** | extraversion (β = -.252**) | 0.319 | 0.102** | agreeableness (β = -.242**) | 0.243 | 0.059** | conscientiousness (β = -.146*) |
| | | | | | | | | | | | | conscientiousness (β = -.165**) | | | |
| | | | | | | | | | | | | neuroticism (β = .152*) | | | |
| 2 | Specific Personality Variables | 3 | 233 - 195 | 0.210 | 0.008 | agreeableness (β = -.155*) | 0.367 | 0.044* | extraversion (β = -.260**) | 0.376 | 0.039** | agreeableness (β = -.242**) | 0.272 | 0.015 | conscientiousness (β = -.136*) |
| | | | | | | | | | neuroticism (β = -.183*) | | | conscientiousness (β = -.181**) | | | neuroticism (β = -.150*) |
| | | | | | | | | | sleep disturbance (β = -.205**) | | | sensation seeking (β = -.200**) | | | openness (β = .160*) |
| 3 | DSI | 5 | 228 - 190 | 0.311 | 0.053* | hazard monitoring (β =.199**) | 0.452 | 0..070** | extraversion (β = -.263**) | 0.398 | 0.017 | | 0.381 | 0.071** | conscientiousness (β = -.170*) |
| | | | | | | | | | Neuroticism (β = -.173*) | | | | | | Neuroticism (β = -.156*) |
| | | | | | | | | | hazard monitoring (β = .198**) | | | | | | thrill seeking (β = .165**) |
| | | | | | | | | | sleep disturbance (β = -.163*) | | | | | | dislike of driving (β = .139*) |
| | | | | | | | | | aggression (β = -.142*) | | | | | | |

*Note: * p<.05, ** p <.01*

Big Five = Agreeableness, Openness, Conscientiousness, Neuroticism, Extraversion

Specific Personality = sensation seeking, cognitive failures, sleep disturbances
DSI = fatigue proneness, hazard monitoring, dislike of driving, thrill seeking, aggression

*Table 9. Countermeasure efficacy regressions: Summary statistics.*

# CHAPTER 4

## Discussion

### General Comments

Findings confirmed that pedestrian perceptions were influenced by features of the intersections, including the level of threat and driver behavior. However, the tentative predictions regarding relative strengths of threat and driver behavior effects were only partly substantiated. Effect sizes were larger for intersection threat than for driver behavior for all categories of appraisal. Similarly, significant effects of the independent variables on countermeasures were obtained, but intersection threat had stronger effects on pedestrian efficacy ratings. Higher threat was associated with greater effectiveness of countermeasures.

Factor analysis suggested that individual differences were structured around driver qualities rather than threat (i.e., pedestrians differ in their relative sensitivities to threats posed by safe, aggressive and distracted drivers). Various associations between personality traits and pedestrian perceptions, and between personality and evaluations of countermeasures, were found. No single principle appeared to explain all these associations. Both general traits, such as those of the Five Factor Model, and the driving-related traits of the DSI were predictive of some pedestrian criteria. In some cases, such as the association between sensation-seeking and lower threat attributed to aggressive drivers, it appeared that pedestrian evaluations might reflect congruence between their personality and the relevant driving behavior. In other cases, such as the negative association between agreeableness and evaluations of safety of distracted driver, some other explanation is necessary.

The remainder of this discussion considers further the impact of intersection characteristics on appraisals of safety and of countermeasure efficiency, conceptual and

methodological issues raised by the research, findings on individual differences, and practical implications.

**Influences on Pedestrian Perceptions**

The effects of the independent variables – intersection threat and driver behavior - on the safety appraisals across the four conceptual categories were not entirely as expected. The prediction that intersection threat would influence appraisal of crosswalk safety more strongly than driver behavior did was confirmed, with a particularly large effect size for the former (partial $\eta^2$=.587). However, contrary to prediction, intersection threat actually had stronger effects on appraisals of driver behavior and of conformity to social norms than the driver behavior manipulation did. Overall, the perception of intersection threat had a greater influence on pedestrian perceptions of safety than driver behaviors.

**The influence of intersection threat.** It could be that pedestrians view driver behaviors as having more of an impact on other drivers than on pedestrians, whereas the geometry of the intersection and the speed of vehicular travel pose more salient challenges to the successful navigation of an intersection. Another broad possibility is that pedestrians may attribute threatening driver behavior more to the characteristics of the traffic environment than to any malicious intent; high-speed traffic may force the driver to behave more aggressively, for example. This hypothesis might explain why intersection threat influenced appraisals of driver behavior and norms.

There may be further explanations for the greater impact of intersection threat on appraisals. Pedestrians may be realistic in feeling that, regardless of driver behavior, vehicles travelling at lower speeds in fewer lanes are less of a threat. Indeed, a pedestrian has a greater

than 80% chance of surviving a crash with a vehicle travelling at 25 MPH (AASHTO, 2004b). A pedestrian involved in a crash with a vehicle travelling at 45 MPH has an 85% chance of serious injury or death. At slower speeds drivers have more opportunity to observe the road ahead and make vehicle corrections in advance of hazards. At higher speeds the window to observe and react is much smaller. Indeed, even if a driver travelling at a high speed can spot a hazard and apply the appropriate reaction, it takes a greater amount of time to stop the vehicle. A vehicle travelling at 25 MPH takes an average of 85 feet to come to a complete stop (AASHTO, 2004a). That same vehicle travelling at 45 MPH would take approximately 195 feet to come to a complete stop. Thus at higher speeds, it may be possible for even the most alert drivers to be unable to execute a corrective action in time to avoid a driving hazard.

The impact of higher-speed intersections on pedestrian perceptions has significance for future highway developments. As the population increases the number of drivers on the roadway will increase as well. This tendency, coupled with the trend for people to move further away from city centers in to suburbs and even further out in to exurbs, creates more traffic on roadways. Adding more capacity in the form of more travel lanes fixes the problem temporarily but also creates a new problem. These higher capacity roadways are also typically higher speed. As the results of this study indicated, pedestrians may view these crossings as a higher threat and choose to cross elsewhere or to avoid walking if possible. This behavior change, in turn, creates more traffic as individuals who could be pedestrians are now operating motor vehicles to avoid the perceived threat of the intersection crossings. This trend, of course, would necessitate the creation of more travel lanes to increase roadway capacity, and the cycle continues.

**The influence of driver behavior.** Even though the effect sizes were larger for intersection threat, the role of driver behavior in pedestrian perceptions of crosswalks should not

be discounted. The effects of behavior had a significant impact on safety appraisal, indicating that roadway geometry and vehicular speed are not the only factors influencing pedestrian appraisals. Likewise, driver behavior also influenced appraisals of adherence to social norms. This finding lends credence to the notion that there are some commonly held notions of courtesy.

Findings showed that distracted drivers were considered to be less safe, and more in violation of social norms, consistent with the observation that distracted driving has recently been brought to the forefront of the American collective conscious (LaHood, 2010b). It is perhaps surprising that aggressive driving is not appraised as more threatening, given that it is this form of unsafe driving behavior that has received the most attention throughout the years (Boyce & Geller, 2002). Several states have active aggressive driving enforcement campaigns and some have gone so far as to increase penalties for those drivers whose violations have been deemed aggressive. However, distracted driving is perhaps more pervasive. It is likely something that all drivers are guilty of at one point or another. Therefore, when judging the safety of driver behaviors pedestrians may recall their own experiences with distracted driving and recognize the potential danger in the behavior. This awareness could possibly explain why distracted driving behaviors were rated as more threatening than aggressive driving behaviors. Publicity given to the dangers of cell-phone use might explain why distracted drivers were also rated highest in violating social norms. However, a more dismal interpretation of the results could be that aggressive driving has become endemic to our society to the point where it has become the rule rather than the exception.

Data analysis also showed an interactive effect of the driver behavior manipulation and intersection threat on appraisals of intersection safety. It appeared to be intersections with the largest number of lanes and fastest speeds where aggressive and distracted driving behaviors are

perceived as the most threatening. In these instances, complex roadway geometry and high speeds are coupled with drivers who are inattentive, lost in thought, vindictive, or angry. These drivers may not spot a pedestrian in time to take corrective action (e.g. slow the vehicle) or, worse, may decide to proceed without need to yield the right of way to the pedestrian. In these instances, when a pedestrian begins a crossing maneuver, that pedestrian is relying on motorists to notice his or her presence in the crosswalk and take appropriate action. As the number of traffic lanes increase so does the time a pedestrian is exposed to oncoming traffic and as speed increases so does the stopping time of the vehicle. This consideration, coupled with drivers who either fail to react due to inattentiveness or willful disregard, certainly increases the perceived threat of higher-speed crossing locations.

**Perceptions of countermeasures.** When examining pedestrian perceptions of countermeasure efficacy, outcomes were much the same. As with safety appraisals, threat seems to have a greater effect on perceived countermeasure efficacy than driver behaviors. In fact, threat was positively associated with perceived countermeasure effectiveness. It appears that respondents were making a judgment about the likely improvement in pedestrian safety and comfort (i.e., an evaluation of change, rather than rating the absolute safety of the crosswalk, which would be assumed to be highest at the slowest speed in any case). Intersection design was perceived as most effective for countering increasing speeds, and education as least related to speed. Driver behavior had a significant main effect only on enforcement, although, again, it was distracted rather than aggressive drivers who were perceived as most in need of legal penalties. There was also a significant interactive effect of the two independent factors on effectiveness of control-based countermeasures. It appeared that interventions increasing control were relatively more effective for distracted and aggressive drivers at slower-speed intersections.

The listing of countermeasures by perceived effectiveness given in Table 2 does not suggest any simple correspondence between overall effectiveness and category of countermeasure. Indeed, the single most effective countermeasure is believed to involve education. However, most of the higher-rated countermeasures are based on engineering solutions to improve design and to improve the pedestrian's sense of control. Design countermeasures directly address intersection geometry and speed. Pedestrians may feel that when addressing problematic roadway geometry and speed issues the behaviors of drivers become less of a problem. It also could be that pedestrians do not believe that countermeasure treatments could be effective in modifying driver behaviors. Indeed, the majority of education and enforcement countermeasures were not rated as being highly effective. Pedestrians may view driver behaviors as being resistant to change -- except via incentives -- whereas threat can be more readily mitigated by physical changes to the roadway.

**Conceptual models for pedestrian research.** A final point in this context is that the conceptual categories initially proposed appear useful for guiding research. That is, following on from the CPM (Scherer, 2001) and TBP (Ajzen, 1988), we can indeed evaluate pedestrian perceptions reliably on the basis of perceived safety, driver threat, control, and social norms. The overall reliability of the eight conceptual categories was high (alpha coefficients >0.80 and in most cases >0.90). The items selected to assess pedestrian perspectives all seemed to cluster into their intended categories. Some finer conceptual distinctions may also be necessary. Initially, both the education and enforcement categories were part of a larger category of social norms. However, results indicated that these items emerged as two distinct groups. Enforcement could be thought of as a corrective action or punitive measure for those individuals who violate the

social norms of the group. In contrast, education could be thought of as informing individuals as to the accepted social norms of the group.

The theory of planned behavior (Ajzen, 1988) allows for the prediction of future behavior, in this instance the prediction of walking behaviors. Previous research (e.g. Eves et al., 2003; Hagger et al., 2002) has found affective attitude and perceived behavioral control are the most predictive of walking behaviors. The results of the present study are consistent with these findings. The largest effect sizes were found in analyses of safety appraisal (pleasantness of crossing) and perceived control. Consistent with the Component Process Model (CPM: Scherer, 2001) framework, threat to safety was rated as the most salient category influencing pedestrian appraisals. As the first study of this kind, it would be premature to attempt to increase walking behaviors by focusing interventions at one of these determinants. The available literature on predicting walking behavior (e.g. Eves et al., 2003; Hagger et al., 2002) has focused on walking as exercise. Further studies looking at walking as a means of transport need to be conducted before developing interventions to increase walking behaviors. At this early, exploratory stage of research the two theories are better seen as sources of relevant concepts rather than as a basis for detailed prediction of pedestrian response. Indeed, the CPM might be better tested by assessing emotional response to crosswalks, and the TPB in studies of intention to walk.

**Methodological issues.** It is also possible that methodological factors influenced the findings on the impact of roadway and driver characteristics. In this study, driver behaviors were conveyed to participants by means of descriptive paragraphs about the behaviors. Physical characteristics of intersections were communicated by both descriptions (i.e., of speed), and images. Sarkar and Andreas (2004, 2006) used black and white photographs of drivers engaged in aggressive acts. These photographs clearly showed the vehicle, driver, and pedestrians in the

vicinity of the vehicle. The actual visual image may have had more of an impact than the use of descriptions in the present study. The determination to use descriptions rather than photographs was made to have more experimental control. The photographs used in the Sarkar and Andreas studies were a mixture of staged scenarios and moments captured as they happened in the field. These images most likely had a higher degree of external validity but they also introduced variance from several areas. The images depicted different vehicle types, different types of pedestrians (e.g. adults, school children, older individuals), and different drivers. Therefore, it would be difficult to determine if a participant's rating was due to the reaction to the act depicted or due to biases to some element(s) of the image.

The rather modest effects of behavior may nevertheless reflect the method by which behaviors were presented (as a narrative) than the actual importance of the behaviors themselves. The effect of driver behaviors on pedestrian appraisals of safety may be greater given more realistic depictions of the driver behaviors. Similarly, driver behaviors did not significantly impact pedestrians' impressions of control. Again, this may have more to do with the lack of realism of the presentation of behaviors than it does with pedestrian indifference to the aggressive or distracted driver bearing down on them.

Pedestrians reported design countermeasures as having the greatest efficacy and educational countermeasures as having the least efficacy. Although this finding could be due to pedestrians having a strong faith in the power of good safety engineering it is probably more likely due to pedestrian familiarity with design countermeasures. That is, pedestrians encounter a wide variety of countermeasure treatments every day throughout the course of a walk. They have the ability to experience these countermeasures first hand. Education is a more nebulous construct. Although the idea of educating drivers on safe driving practices and driving in a

manner that is courteous to pedestrians is a sound one, pedestrians may doubt the ability of an educational program to be successfully mounted. NHTSA (2002) has led the way in educating drivers on safe driving practices, but even with the best teacher ultimately the learning and application of what is learned is up to the student. If the student, in this case the driver, is not receptive to the message, even the best educational campaigns will not be successful.

Future studies of this nature should look to increase the realism of both the intersections and driver behavior. Viewing a static intersection and being told aggressive drivers are travelling through at 45 MPH may allow a pedestrian a sense of detachment from the scene. However, being physically present at an intersection and hearing car honking and people shouting as cars whiz by at 45 MPH may provide a completely different experience. Changing the realism of the intersections and driver behaviors may have some impact on how pedestrians appraise the safety of the intersection and the efficacy of countermeasures.

Placing pedestrians in real-world and potentially dangerous intersections may not be practical or even advisable. However, it may be possible to increase the realism of the intersections and behaviors through photographs, videos, simulations, and even staged crossings on closed-course roadways. Future research may also use virtual reality methods.

**Individual Differences in Pedestrian Perceptions**

The data also suggested that there may be substantial individual differences in pedestrians' perceptions. A crosswalk that seems safe and controllable to one person may be appraised as threatening to another. The factor analyses illustrated the principle that analyses focusing on differences in means may provide quite different information to analyses of individual differences. Specifically, although intersection threat was the major factor determining

mean levels of safety appraisal and countermeasure efficacy variables, it did not feature in the dimensional structure of perceptions. Instead, factor structures are mainly organized by appraisals of driver characteristics, specifically levels of concern about safe, aggressive and distracted drivers. Comparable factors emerged in analyses of both the appraisal and countermeasure data, with beliefs about education emerging as a fourth factor in the latter analysis. Thus, by contrast with the comparisons of means, individual differences in perceptions are personalized, and focused on qualities of drivers.

As mentioned previously, multiple, independent predictors of the pedestrian criteria were found in the regression analyses. There is no clear overarching principle that accommodates these various findings, and, thus, discussion of specific findings here will be selective and brief. In relation to the Five Factor model, previous research (Rhodes, 2006) has found conscientiousness to have a positive influence on walking behaviors. In the present study conscientiousness was found to be a significant predictor of aggression- and education-related countermeasure efficacy ratings, as well as safety appraisals for aggressive drivers. Conscientious pedestrians see aggressive drivers as being safer, and also think that countermeasures directed towards these drivers are less effective (perhaps because they are less in need of interventions). It is not clear that these findings correspond to those of Rhodes (2006); indeed, they suggest that studies of walking for exercise or leisure may have limited relevance to the particular issue of pedestrian response to traffic. In the present study, the effects of agreeableness were also significant. Agreeableness was a significant negative predictor of safety appraisals for distracted drivers. It also significantly predicted negative countermeasure efficacy ratings for safe and aggressive focused countermeasures. Possibly, this trait relates to some general concerns about road safety.

Turning to the more narrowly defined traits, sensation seeking predicted appraisals of distracted drivers as more threatening and aggressive drivers as more safe. This finding could relate to the idea of pedestrian-driver sympathy or rapport. Sensation seekers may feel in control of their own actions and enjoy the 'rush' from more extreme experiences (Zuckerman, 2006). They may therefore perceive aggressive drivers as also being in control and may attribute the driver's behaviors to seeking a more extreme experience. Perhaps too they believe that sensation-seeking activities require focused attention, and thus distraction looms larger as a threat to safety.

Driver-specific personality traits, measured by the DSI provided a significant explanation of variance beyond personality, supporting in part the idea that individuals have stable self-beliefs specific to the driving or traffic context. However, various general personality traits continued to predict with driving traits included in the regression equations, showing that both types of personality construct are relevant to the pedestrian experience. Specifically, hazard monitors rated countermeasures for safe and distracted drivers as less effective. These individuals may feel their own diligence is not shared by others. Thrill seekers rated distracted drivers as less safe. Since thrill seeking refers to extreme experiences and these experiences typically require being fully present in the moment, perhaps thrill seekers find the idea of drivers not fully attending to the task at hand particularly dangerous.

Broadly, findings confirm that personality may influence pedestrian perceptions. However, at least in the present data, personality effects seem to be made up of a number of small, specific biases associated perhaps with attitudes towards specific types of drivers. Further research might explore the effects of specific traits in more depth.

## Practical Implications

The need for more research on determinants of pedestrian walking behavior is not likely to subside. Indeed, the need for this research becomes more urgent as the policies within the United States focus on a decreased dependence on foreign oil, a decrease in traffic congestion, management of the obesity epidemic, and environmental stewardship. Although walking alone cannot solve these issues, it is a vital component. Leaving automobiles at home and walking to more destinations reduces the need for foreign oil. The more people walk to destinations, the less traffic there is on the road. As a physical activity, walking has the beneficial side effect of providing exercise and thus improving health. Lastly, walking is a low-carbon environmentally friendly transportation method. As these policies become higher national priorities, walking will increasingly be in the spotlight as a low-cost, expedient, and easy to implement solution.

**Increasing livability.** The idea of environmentally sustainable communities with easy access to necessary amenities is not a new one. However, the idea of such communities has often been thought to be out of reach or cost-prohibitive. Now, the ideal of livable communities is being presented as a right of all citizens (LaHood, Donovan, & Jackson, 2009). The creation and sustaining of walkable communities will play an integral part in the successful implementation of livable communities. If the livability initiatives outlined by LaHood et al. (2009) are successful, walking will become a viable transportation option for all. However, this goal requires not only changes to the existing infrastructure but also an understanding of why pedestrians walk or why they choose not to walk. The present study should provide a starting point for future research looking at livability from a user-centered approach. The livability initiatives outlined cannot be achieved unless the users, in this case pedestrians, utilize the

transportation system. Incorporating the elements that increase pedestrian feelings of safety (pleasantness) and control will ultimately increase the usage of the system.

**Incorporating pedestrian assessments in level of service.** A level of service metric for pedestrians is still in its infancy. Although adapted from the roadway LOS model (see AASHTO, 2004a and Transportation Research Board, 2000 for a review), the pedestrian LOS metric has many requirements and challenges that are not present in roadway LOS calculations. The main concern when calculating roadway LOS is capacity. That is, on a given segment of roadway, the number of cars that can pass per hour at the posted speed limit without encountering delay. The variables in the roadway LOS calculation are relatively straightforward. The average number of vehicles (per hour, per day, etc.), the number of traffic lanes, condition of asphalt, etc. can all be easily determined. Determining pedestrian LOS involves more than just determining capacity (Landis et al., 2001). A key factor in determining pedestrian LOS is the actual pedestrian perceptions of a walking facility. However, this factor has been frequently ignored (e.g., Nabors et al., 2007; Petritsch et al., 2005). The present study illustrates that pedestrians' perceptions of intersection characteristics do impact their feelings of safety and control. Furthermore, these feelings may impact decisions to walk. Although it is doubtful that pedestrians would find a crossing so unappealing that they decided not to cross (or walk) at all, it is certainly possible that when presented with the option of walking or driving to a location the appeal of a crossing would certainly be a factor. Ultimately, if pedestrians deem a crossing to be unpleasant they may opt to use other transport methods rather than navigate through an unpleasant cross. Incorporating pedestrian appraisals of intersections will result in a LOS figure that is more representative of the actual crossing location, taking into account the features unique to pedestrian LOS: the pedestrians.

**Facility design, research, and policy.** Current US DOT policy (LaHood, 2010a) states that pedestrians shall be accommodated in new construction projects when practical. The policy goes on to state that pedestrian facilities should be retrofitted into existing roadway systems when possible. However, the policy stops short of providing any design guidance. The policy is also vague as to when it is considered practical to include pedestrians. This is one instance when pedestrian perceptions could be used to assist in determining the practicality of installing pedestrian facilities. For example, a proposed roadway construction project could incorporate four through lanes of traffic in each direction and accommodate vehicles at 50 MPH. Because this roadway is not a highway where pedestrian traffic is specifically prohibited the design team should also design pedestrian facilities. Assessing pedestrian perceptions of the proposed roadway would be a vital first step. This would enable planners to determine how pedestrians appraise the level of threat of the intersections and what countermeasures they would find the most effective. Ultimately, by incorporating the pedestrian as part of the design process the resultant facility should be well utilized by all end-users of the roadway.

## Future Research Directions

As the first of its kind, this study represents a solid, if small, first step towards incorporating pedestrian assessments into the pedestrian facility design process. Understanding how pedestrians react to different driver behaviors can assist in prioritizing education and enforcement countermeasures. Likewise, understanding how pedestrians perceive the threat of an intersection can assist in the development and installation of appropriate control and design countermeasures. As this study is just a first step, there is much still to be done.

**Intersection reality.** One of the first steps in future research is to improve upon the reality of the presented intersections and driver behaviors. Sarkar and Andreas (2004, 2006) used photographs and achieved similar results. However, there results were based on the perspective of drivers, not pedestrians. It is unknown if similar effects would be achieved from a pedestrian perspective when looking at these same issues and using the same presentation mode.

Technological advancements may allow for an even greater sense of realism without placing pedestrians in situations with undue danger. Simulation technology has evolved to the point where pedestrians can be placed in a virtual reality environment and different roadway scenarios and driver behaviors can be tested without a pedestrian ever having to leave a laboratory (Wu, Ashmead, Bodenheimer, 2009).

A lower cost, but still higher fidelity option, would be to have pedestrians watch filmed intersections. In this way, pedestrians would still get the sense of the sights and sounds of the intersection without being exposed to danger.

Finally, field data collection methods could be utilized. Being at actual intersections would have the highest correspondence to reality. However, this method would also put pedestrians at the greatest potential risk. Field data collection is a very useful tool but is a technique best deployed after other exploratory studies have established more information regarding pedestrian appraisals.

**Expanding evaluation methods.** Future research should look into expanding the assessment of general personality factors, specific personality factors, and driving-related personality factors. In the present study the 'Big Five' personality factors were assessed using a brief questionnaire (Saucier, 2003). Although this questionnaire has been validated, with only 40 items, the nuances of personality are lost. A more comprehensive personality metric, such as the

comprehensive NEO-PI-R questionnaire developed by Costa and McCrae (1992) may provide more detailed results regarding the effects of personality on pedestrian appraisals.

Investigations of countermeasure efficacy could be expanded to provide actual examples of countermeasures. If individuals are able to see examples of countermeasures or experience them in some other way, their ratings of efficacy may change. For example, chicanes are very effective in slowing vehicle speeds. An individual able to view a driver navigating through chicanes (either through video, in the field, or with simulation) may have a more accurate concept of the countermeasure and be better able to assess its efficacy for a given situation.

Follow up interviews or focus group methods could be employed to provide some supplementary qualitative data. This information could potentially provide insight in to what aspects of intersection threat and driver behavior pedestrians find particularly important. Then with this information, a modified questionnaire instrument could be developed. This method could then provide more detailed information about the effects of driver behavior and intersection threat on pedestrian decisions to walk and ultimately lead to effective, targeted countermeasure treatments.

Lastly, perceptions of aggressive and distracted driving behaviors need to be investigated more thoroughly. If aggressive driving has become endemic to society its affects, though still a threat to safety, may not be viewed as problematic. This in turn, impacts how aggressive driving behaviors are perceived. It would also be of value to determine the types of distracted behaviors pedestrians find the most threatening. There are a myriad of stimuli both inside and outside the vehicle to divert a driver's attention. Eliminating all sources of distraction is not practical. Therefore, understanding which distracted behaviors pedestrians find the most threatening can

assist in the development of target countermeasures that increase the appeal of an intersection and ultimately increase pedestrian safety.

## REFERENCES


Active Community Transportation Act of 2010, H.R. 4722, 111h Cong. (2010).

Ajzen, I. (1988). *Attitudes, personality, and behavior*. Chicago: Dorsey Press.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50,* 179 – 211.

Ajzen, I., & Fishbein, M. (1977). Attitude behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin, 84,* 888-918.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior.* Englewood Cliffs, NJ: Prentice Hall.

American Association of State Highway and Transportation Officials (AASHTO) (2004a). *A policy on geometric design of highways and streets* (5th ed.). Washington, D.C.: Author.

American Association of State Highway and Transportation Officials (AASHTO) (2004b). *The guide for the planning, design, and operation of pedestrian facilities.* Washington, D.C.: Author.

American Psychological Association [APA] (2010). *Ethical principles of psychologists and code of conduct.* Retrieved from: http://www.apa.org/ethics/code/index.aspx

Americans With Disabilities Act of 1990, 42 U.S.C.A. § 12101 *et. seq.* (West 1993).

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology*, *40,* 471-499.

Austin, J. T., & Vancouver, J. B. (1996). Goal constructs in psychology: Structure, process, and content. *Psychological Bulletin, 120*, 338-375.

AutoVantage. (2008). *AutoVantage road rage survey*. Nashville, TN: Prince Market Research.

Boyce, T. E. & Geller, E. S. (2002). An instrumented vehicle assessment of problem behavior and driving style: Do younger males really take more risks? *Accident Analysis and Prevention, 34,* 51-64.

Brijs, K., Daniels, S., Brijs, T., & Wetts, G. (2010, January). *An experimental approach towards the evaluation of a seat belt campaign with an inside view on the psychology behind seat belt use.* Paper presented at the 88th meeting of the Transportation Research Board, Washington, D.C.

Cattell, R.B. (1973). *Personality and mood by questionnaire.* San Francisco: Jossey-Bass.

Cervero, R., & Radisch, C. (1996). Travel choices in pedestrian versus automobile oriented neighbourhoods. *Transport Policy, 3,* 127-141.

Complete Streets Act of 2009, H.R. 1443, 111h Cong. (2009).

Cornog, M. & Gelinne, D. (2001, May/June).World class streets. *Public Roads, 73.* Retrieved from: http://www.fhwa.dot.gov/publications/publicroads/10mayjun/03.cfm

Costa, P.T., Jr., & McCrae, R.R. (1992). *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) manual.* Odessa, FL: Psychological Assessment Resources.

Deffenbacher, J. L., Lynch, R. S., Filetti., L. B., Dahlen, E. R., & Oetting, E. R. (2003). Anger, aggression, risky behavior, and crash-related outcomes in three groups of drivers. *Behaviour Research and Therapy, 41,* 333-349.

Dorn, L., & Matthews, G. (1995). Prediction of mood and risk appraisals from trait measures: Two studies of simulated driving. *European Journal of Personality, 9,* 25-42.

Dula, C. S., & Ballard, M. E. (2003). Development and evaluation of a measure of dangerous, aggressive, negative emotional, and risky driving. *Journal of Applied Social Psychology*, *33*, 263-282.

Dula, C.S. & Geller, E.S. (2004). Risky, aggressive, or emotional driving: Addressing the need for consistent communication in research. *Journal of Safety Research, 34,*559–566.

Enhancing Livability for All Americans Act of 2009, H.R. 4287, 111h Cong. (2009).

Eves, F., Hoppe, R., & McLaren, L. (2003). Prediction of specific types of physical activity using the theory of planned behaviour. *Journal of Applied Biobehavioral Research, 8,* 77-95.

Federal Highway Administration. (1972). *Transportation characteristics of school children (*FHWA Report No. 4). Nationwide Personal Transportation Study. Washington, DC: Government Printing Office.

Federal Highway Administration. (1994). *The National bicycling and walking study - Transportation choices for a changing America*; Final Report (FHWA Publication No. PD-94-023). Washington, D.C.: Government Printing Office.

Federal Highway Administration. (2004). *Summary of travel trends: 2001 National household travel survey*. Retrieved from: http://nhts.ornl.gov/2001/pub/STT.pdf

Gallin, N. (2001) *Quantifying pedestrian friendliness – Guidelines for assessing pedestrian level of service.* Paper presented at the International Conference on Walking, Perth, Australia.

Giles-Corti, B., & Donovan, R. J. (2002). Socioeconomic status differences in recreational physical activity levels and real and perceived access to a supportive physical environment. *Preventive Medicine, 35*, 601-611.

Goldberg, L. R. (1993). The structure of phenotypic personality traits. *American Psychologist*, *48*, 26–34.

Google Earth (Version 5.2) (2009). [Computer software]. Mountain View, CA: Google, Inc.

Grandjean, D., Sander, D., & Scherer, K. R. (2008). Conscious emotional experience emerges as a function of multilevel, appraisal-driven response synchronization. *Consciousness and Cognition, 17*, 484-495.

Groeger, J.A. & Brown, I.D. (1989). Assessing one's own and others' driving ability: Influences of sex, age, and experience. *Accident Analysis and Prevention, 21,*155–168.

Hagger, M.S., Chatzisarantis, N. & Biddle, S.J.H. (2002). The influence of autonomous and controlling motives on physical activity intentions within the theory of planned behaviour. *British Journal of Health Psychology, 7*, 299-316.

Hakamies-Blomqvist, L. (2006). Are there safe and unsafe drivers? *Transportation Research Part F, 9,* 347-352.

Hawthorne, W. (1989). *Why Ontarians walk, why Ontarians don't walk more: A study of the walking habits of Ontarians.* Energy Probe Research Foundation: Ontario.

Horrey, W.J. & Wickens, C.D. (2004). Driving and side task performance: The effects of display clutter, separation, and modality. *Human Factors, 46*, 611-624.

Howard, J.H., Cunningham, D.A., Rechnitzer, P.A. (1987). Personality and fitness decline in middle-aged men. *International Journal of Sport Psychology, 18,* 100-111.

Hummel, T. (1999). *Dutch pedestrian safety research review* (FHWA Publication No. FHWA-RD-99-092). Washington, D.C.: Government Printing Office.

Hutchinson, T. P. (2008). *Road courtesy and road safety.* Retrieved from Centre for Automotive Safety website: http://casr.adelaide.edu.au/publications/researchreports

Killingsworth, R., & Lamming, J. (2001). Development and public health: Could our development patterns be affecting our personal health? *Urban Land, 60*, 12–17.

LaHood, R.H. (2010a, March 11). United States Department of Transportation policy statement on bicycle and pedestrian accommodation regulations and recommendations [Press release]. Retrieved from: http://www.dot.gov/affairs/2010/bicycle-ped.html

LaHood, R. H. (2010b, January 12). Focus-Driven advocates share their stories in campaign to end distracted driving [Web log post]. Retrieved from: http://fastlane.dot.gov/2010/01/focusdriven-advocates-share-their-stories-in-campaign-to-end-distracted-driving.html

LaHood, R.H., Donovan, S., Jackson, L (2009, June 16). Partnership for sustainable communities, partnership sets forth 6 'livability principles' to coordinate policy [Press release]. Retrieved from: http://yosemite.epa.gov/opa/admpress.nsf/0/F500561FBB8D5A08852575D700501350

Lajunen, T., & Summala, H. (1995). Driving experience, personality and skill and safety-motive dimensions in drivers' self-assessments. *Personality and Individual Differences, 19,* 307-318.

Lamble, D., Laakso, M., & Summala, H. (1999). Detection thresholds in car following situations and peripheral vision: Implications for positioning of visually demanding in-car displays. *Ergonomics, 42,* 807-815.

Landis, B.W., Vattikuti, V.R., Ottenberg, R. M., McLeod, D.S., & Guttenplan, M. (2001). Modeling the roadside walking environment: Pedestrian level of service. *Transportation Research Record, 1773,* 82-88.

Lazarus, R.S. (1966). *Psychological stress and the coping process*. New York: McGraw-Hill.

Lee, J.D., McGehee, D.V., Brown, T.L., & Reyes, M.L. (2002). Collision warning timing, driver distraction, and driver response to imminent rear-end collisions in a high fidelity driving simulator. *Human Factors, 44,* 313-334.

Manson, J. E., Hu, F.B., & Rich-Edwards, J.W. (1995). A prospective study of walking as compared with rigorous exercise in the prevention of coronary heart disease. *New England Journal of Medicine*, *341,* 650–658.

Matthews, G. (2002). Towards a transactional ergonomics for driver stress and fatigue. *Theoretical Issues in Ergonomics Science, 3,* 195-211.

Matthews, G., Campbell, S. E., Desmond, P. A., Huggins, J., Falconer, S., & Joyner, A. (1999). Assessment of task-induced state change: Stress, fatigue and workload components. In M. Scerbo (Ed.), *Automation technology and human performance: Current Research and Trends*, (pp. 199-203). Hillsdale, NJ: Erlbaum.

Matthews, G., Deary, I.J., & Whiteman, M.C. (2009). *Personality traits* (3rd ed.). Cambridge: Cambridge University Press.

Matthews, G., Desmond, P., Joyner, L., Carcary, B., & Gilliand, K. (1996, May). *Validation of the Driver Stress Inventory and Driver Coping Questionnaire.* Paper presented at the International Conference on Traffic and Transport Psychology, Valencia, Spain.

Matthews, G., Desmond, P.A., Joyner, L.A., & Carcary, B. (1997). A comprehensive questionnaire measure of driver stress and affect. In E. Carbonell Vaya & J.A. Rothengatter (Eds.), *Traffic and transport psychology: Theory and application* (pp. 317-324). Amsterdam: Pergamon.

Matthews, G., Dorn, L., Hoyes, T.W., Davies, D.R., Glendon, A.I., & Taylor, R.G. (1998) Driver stress and performance on a driving simulator. *Human Factors, 40*, 136-149.

Matthews, G., Emo, A.K., & Funke, G. J. (2005, June). *A short version of the Dundee Stress State Questionnaire.* Paper presented at the Twelfth Meeting of the International Society for the Study of Individual Differences, Adelaide, Australia.

Matthews, G., Emo, A.K., Funke, G., Zeidner, M., Roberts, R.D., Costa, P.T., Jr., & Schulze, R. (2006). Emotional intelligence, personality, and task-induced stress. *Journal of Experimental Psychology: Applied, 12*, 96-107.

Matthews, G., Tsuda, A., Xin, G., & Ozeki, Y. (1999) Individual differences in driver stress vulnerability in a Japanese sample. *Ergonomics, 42,*401-415.

McKenna, F.P. (1993). It won't happen to me: Unrealistic optimism or illusion of control? *British Journal of Psychology, 84,* 39–50.

McKenna, F.P., Stainer, R.A., & Lewis, C. (1991). Factors underlying illusory self-assessment of driving skills in males and females. *Accident Analysis and Prevention, 23,* 45–52.

Nabors, D., Gibbs, M., Sandt, L., Rocchi, S., Wilson, E., & Lipinski, M. (2007). *Pedestrian road safety audit guidelines and prompt list* (FHWA Publication No. FHWA-SA-07-007). Washington, D.C.: Government Printing Office

National Highway Traffic Safety Administration. (2002). *Aggressive driving enforcement: Strategies for implementing best practices.* Retrieved from: http://www.nhtsa.gov/people/injury/enforce/aggressdrivers/aggenforce/index.html

Pedestrian Environment Review System. (2004). [Computer software]. Wokingham, Berkshire, England: TRL Software.

Peters, M. E. (2002, July/August). Growing traffic congestion threatens nation's economy, quality of life. *Public Roads, 66,* 1.

Petritsch, T.A., Landis, B.W., McLeod, P.S, Huang, H.F., Challa, S., & Guttenplan, M. (2005). Level of service model for pedestrians at signalized intersections. *Transportation Research Record, 1939*, 55-62.

Quenault, S. W. (1968). Driver behaviour—safe or unsafe behaviours II. *Road Research Board*, Laboratory Report 146.

Rhodes, R.E. (2006). The built-in environment: The role of personality with physical activity. *Exercise and Sport Sciences Reviews, 34,* 83-88.

Rhodes, R.E., & Smith, N.E.I. (2006). Personality correlates of physical activity: A review and meta-analysis. *British Journal of Sports Medicine, 40,* 958 – 965.

Rhodes, R.E., Courneya, K.S., Blanchard, C.M., & Plotnikoff, R.C. (2007). Prediction of leisure-time walking: An integration of social cognitive, perceived environmental, and personality factors. *International Journal of Behavioral Nutrition and Physical Activity, 4,* 51.

Rotter, J.B. (1966). Generalized expectancies of internal versus external control of reinforcements. *Psychological Monographs, 80,* 609.

Safe Routes to High Schools Act of 2009, H.R. 4021, 111h Cong. (2009).

Safe Routes to School Act of the Safe, Accountable, Flexible, Efficient Transportation Act – a Legacy for Users of 2005, 23 U.S.C. § 1404 (West 2006).

Safe, Accountable, Flexible, Efficient Transportation Act – a Legacy for Users of 2005, 23 U.S.C. § 1202 (West 2006).

Sallis, J.F., Johnson, M.F., Calfas, K.J., Caparosa, S., & Nichols, J.F. (1997). Assessing perceived physical environmental variables that may influence physical activity. *Research Quarterly for Exercise and Sport, 68,* 345-351.

Sander, D., Grandjean, D., Scherer, K. R. (2005). A systems approach to appraisal mechanisms in emotion. *Neural Networks, 18,* 317–352.

Sarkar, S. & Andreas, M. (2004). Drivers' perception of pedestrians' rights and walking environments. *Transportation Research Record, 1878*, 75–82.

Sarkar, S. & Andreas, M. (2006, January). *Perceptions of aggressive driving behavior.* Paper presented at the meeting of the Transportation Research Board, Washington, D.C.

Sarkar, S., Martineau, A., Emami, M., Khatib, M., & Wallace, K. (2000). Spatial and temporal analyses of the variations in aggressive driving and road rage behaviors observed and reported on San Diego freeways. *Transportation Research Record, 1724*, 7-13.

Saucier, G. (2003). Orthogonal markers for orthogonal factors: The case of the big five. *Journal of Research in Personality, 36,* 1-31.

Scherer, K. R. (2001). Appraisal considered as a process of multi-level sequential checking. In K. R. Scherer, A. Schorr, & T. Johnstone (Eds.), *Appraisal processes in emotion: Theory, methods, research* (pp. 92–120). New York: Oxford University Press.

Shaw, T.H., Matthews, G., Warm, J.S., Finomore, V., Silverman, L., & Costa, P.T., Jr. (2010). Individual differences in vigilance: Personality, ability and states of stress. *Journal of Research in Personality, 44,* 297-308.

Sisiopiku, V. P., & Akin, D. (2003) Pedestrian behaviours at and perceptions towards various pedestrian facilities: An examination based on observation and survey data. *Transportation Research Part F, 6,* 249-274.

Smith, R., Reed, S., & Baker, S. (2010, July/August). Street design: Part 1 – complete streets. *Public Roads, 74.* Retrieved from: http://www.fhwa.dot.gov/publications/publicroads/10julaug/03.cfm

Stead, M., Tagg, S., MacKintosh, A.M., & Eadie, D. (2005). Development of a mass media theory of planned behavior intervention to reduce speeding. *Health Education Research, 20,* 36-50.

Tasca, L. (2005, October). *Driver distraction: Towards a working definition.* Paper presented at the International Conference on Distracted Driving, Toronto, ON, Canada.

Transportation Research Board (TRB) (2000). *Highway capacity manual.* Washington, D.C.: Author.

Tsimhoni, O. (2003). *Time-sharing of a visual in-vehicle task while driving: Findings from the task occlusion method* (Technical Report UMTRI-2003-13). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

United States Department of Commerce, Census Bureau (2004). *Journey to work: 2000* (USDOC Publication NO. C2KBR-33). Retrieved from: http://www.census.gov/population/www/cen2000/briefs/

Walton, D. (1999). Examining the self-enhancement bias: Professional truck drivers' perceptions of speed, safety, skill and consideration. *Transportation Research Part F, 2*, 91–113.

Walton, D., & Bathurst, J. (1998). An exploration of the perceptions of the average driver's speed compared to perceived driver safety and driving skill, *Accident Analysis and Prevention, 30,* 821-30.

Weinstein, A., Felgley, P., Pullen, P., Mann, L., & Redman, L. (1999). Neighborhood safety and the prevalence of physical inactivity – selected states. *Journal of the American Medical Association, 281,* 1373.

Wierwille, W.W. & Tijerina, L. (1998, December). *Modeling the relationship between driver in-vehicle demands and accident occurrence.* Paper presented at the Vision in Vehicles VI, Derby, England.

Wu, H., Ashmead, D.H., Bodenheimer, B. (2009). Applied perception in graphics and visualization. *Proceedings of the 6th Symposium on Applied Perception in Graphics and Visualization,* 35 – 40.

Zegeer, C.V., Seiderman, C., Lagerwey, P., Cynecki, M., Ronkin, M., & Schneider, R. (2002). *Pedestrian facilities users' guide: Providing safety and mobility* (FHWA Publication No. FHWA-RD-01-102). Washington, D.C.: Government Printing Office.

Zuckerman, M. (2006). *Sensation seeking and risky behavior.* Washington, D.C.: American Psychological Association.

## APPENDIX A:

### Participants' Responses to Types of Walking Activities Engaged in During the Past Week

| | Yes | No |
|---|---|---|
| To walk or exercise the dog | 14.93% | 85.07% |
| On the way to or from work | 22.39% | 77.61% |
| On the way to or from school | 88.81% | 11.19% |
| On the way to or from public transportation | 20.52% | 79.48% |
| Escorting children to or from school | 1.49% | 98.51% |
| To shop or run errands | 66.42% | 33.58% |
| For exercise | 52.24% | 47.76% |
| For any other reason* | 27.61% | 72.39% |
| | | |
| * Reasons given included volunteering, enjoying the weather, and walking for charity run/walk events | | |

# APPENDIX B:

## Intersection Images and Behavior Descriptions

## Driving Behaviors

**Safe Driving Behaviors**

You are at a 2 lane intersection with a posted speed of 25 MPH waiting to cross the street. While waiting you notice most of the approaching traffic appears to be courteous. Drivers are maintaining a safe distance between vehicles and looking out for pedestrians on or near the roadway. Vehicles are stopping before the marked crosswalk to allow pedestrians the full use of that area when crossing the road. Divers all appear to be obeying the posted speed limit.

You are at a 4 lane intersection with a traffic median waiting to cross the street. The posted speed of the road is 35 MPH. You notice most of the approaching traffic appears to be courteous. Drivers are obeying posted speed limits. You notice drivers looking for pedestrians and maintaining a safe distance between vehicles. Vehicles are stopping before the marked crosswalk giving pedestrians the full use of the crosswalk area when traveling.

You are at a 4 lane intersection with a traffic median waiting to cross the street. The posted speed of the road is 45 MPH. You observe that most drivers appear to be courteous. Drivers are stopping before the marked crosswalk so that pedestrians may have full use of the crosswalk area. Drivers also are all obeying the posted speed limit. They are maintaining a safe distance between vehicles and are looking for pedestrians in or near the roadway.

**Distracted Driving Behaviors**

You are at a 2 lane intersection with a posted speed of 25 MPH waiting to cross the street. You notice some drivers in approaching traffic seem to be distracted. You observe some drivers texting or talking on cell phones while driving. Others are changing radio stations. Still others appear to be fatigued or lost in thought.

You are at a 4 lane intersection with a posted speed of 35 MPH waiting to cross the street. As you wait, you notice many of the approaching drivers seem to be distracted. Some drivers are adjusting the radio. Others are talking on cell phones or texting while driving. Still other seem to be absent minded or fatigued.

You are at a 4 lane intersection with a traffic median waiting to cross the street. The posted speed of the road is 45 MPH. Drivers in approaching traffic appear to be distracted. You notice some drivers appear to be ‘daydreaming’ or are fatigued. Others are talking on cell phones or text messaging. Some appear to be changing radio stations.

**Aggressive Driving Behaviors**

You are at a 2 lane intersection with a posted speed of 25 MPH waiting to cross the street. As you wait to cross you notice most of the drivers in approaching traffic appear to be frustrated and impatient. Some vehicles are going through stops signs without first coming to a complete stop while others are erratically changing lanes. Some drivers are honking horns and making rude gestures at one another.

You are at a 4 lane intersection with a posted speed of 35 MPH waiting to cross the street. As you watch the approaching traffic you notice that drivers seem frustrated and impatient. You hear horns honking and see drivers making rude gestures at one another. You notice some vehicles going through the stop sign without making a complete stop while other vehicles are changing lanes erratically.

You are at a 4 lane intersection with a traffic median waiting to cross the street. The posted speed of the road is 45 MPH. You notice some drivers appear to be frustrated and impatient. Drivers are making rude gestures at one another and honking their horns. Many drivers are going through stop signs without first coming to a complete stop. Some drivers are changing lanes erratically.

Intersection Photographs

Practice Road

Backlick Road and Commerce Street
Springfield, VA


Bird's Eye View of Intersection


Street Level View of Intersection

Two Lane Road 25 MPH Speed Limit

Stanton Rd and Elvans Rd SE
Washington, DC

Bird's Eye View of Intersection


Street Level View of Intersection

8th St NE and F St NE
Washington, DC


Bird's Eye View of Intersection


Street Level View of Intersection

6th St and S St NW
Washington, DC


Bird's Eye View of Intersection


Street Level View of Intersection

Four Lane Road 35 MPH Speed Limit

South Dakota Ave and Michigan Ave NE
Washington, DC


Bird's Eye View of Intersection


Street Level View of Intersection

U St and 14th St NW
Washington, DC

Bird's Eye View of Intersection


Street Level View of Intersection

6th St and K St NW
Washington, DC


Bird's Eye View of Intersection


Street Level View of Intersection

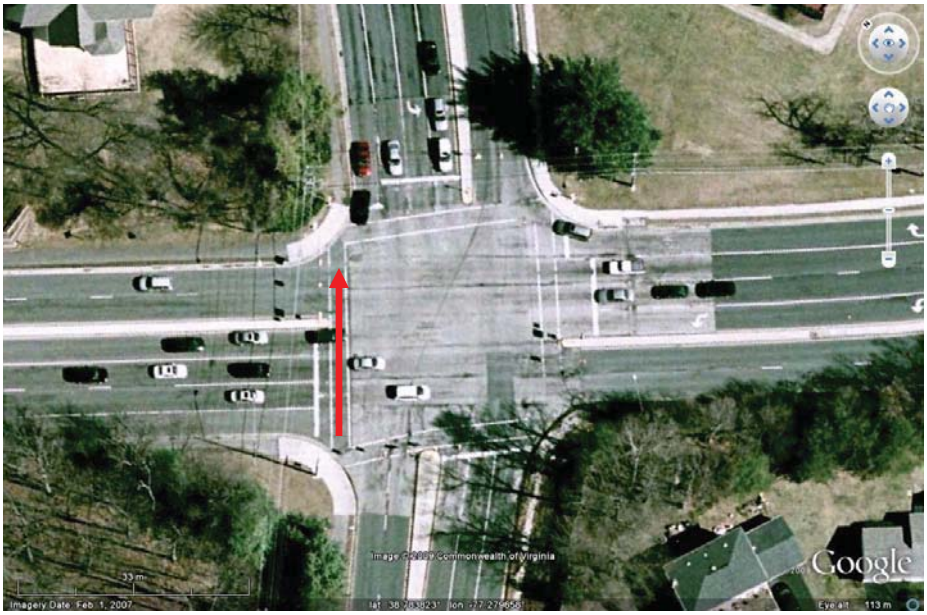
Four Lane Road with Median 45 MPH Speed Limit

Layhill Road and Bel Pre Road
Aspen Hill, MD


Bird's Eye View of Intersection


Street Level View of Intersection

Burke Lake Road and Burke Centre Parkway
Burke, VA




Bird's Eye View of Intersection


Street Level View of Intersection

Wilson Lane and River Road
Bethesda, MD

Bird's Eye View of Intersection


Street Level View of Intersection

## REFERENCES


"6th St and K St NW Washington, DC." 38.90296, -77.01982. (2008). *Google Earth.*

"6th St and S St NW Washington, DC." 38.91454, -77.01985. (2008). *Google Earth.*

"8th St NE and F St NE Washington, DC." 38.89773, -76.99485. (2008). *Google Earth.*

"Backlick Road and Commerce Street Springfield, VA." 38.78249, -77.18546

"Burke Lake Road and Burke Centre Parkway Burke, VA. 38.78431, -77.27981. (2008). *Google Earth.*

"Layhill Road and Bel Pre Road Aspen Hill, MD." 39.09105, -77.04493. (2008). *Google Earth.*

"South Dakota Ave and Michigan Ave NE Washington, DC." 38.94286, -76.98326. (2008). *Google Earth.*

"Stanton Rd and Elvans Rd SE Washington, DC." 38.85495, -76.98588. (2008). *Google Earth.*

"U St and 14th St NW Washington, DC." 38.91747, -77.03201. (2008). *Google Earth.*

"Wilson Lane and River Road Bethesda, MD." 38.98393, -77.13784. (2008). *Google Earth.*

# APPENDIX C:

# Questionnaires

**Demographic Information**

Today's Date _____ Time of day _____am/pm

Age: _____ (years) Sex: M F (circle one)

Occupation: _____

If student, please indicate your year in school (circle one):

Freshman Sophomore Junior Senior Senior + (5 or more years of college)

1. Please state the year you obtained a full driver's license: _____
2. Please state your age at the time you obtained your full driver's license: _____
3. About how often do you drive nowadays?
   a. Everyday
   b. 2-3 days per week
   c. About once per week
   d. Less than once per week
4. Estimate roughly how many miles you have personally driven in the last year:
   a. Less than 5,000 miles
   b. 5,000 – 10,000 miles
   c. 10,001 – 15,000 miles
   d. 15,001 – 20,000 miles
   e. Over 20,000 miles
5. Do you drive to and from your place of work
   a. Everyday
   b. Most days
   c. Occasionally
   d. Never
6. Please state which of these road types you use most often (check one or more boxes):
   a. Freeways
   b. Other main roads
   c. Urban roads
   d. Country roads
7. During the last three (3) years how many **minor** accidents have you been involved in? (A minor accident is one in which no-one required medical treatment AND the cost of damage to vehicles and property was less than $800)

   Number of minor accidents:_____ (if none write 0)
8. During the last three (3) years how many **major** accidents have you been involved in? (A major accident is one in which EITHER someone required medical treatment OR the cost of damage to vehicles and property was more than $800).

   Number of major accidents: _____ (if none write 0)
9. During the past three (3) years have you been convicted of:

   Circle the correct response for each

   a. Speeding Yes No
   b. Careless or dangerous driving Yes No
   c. Driving under the influence of alcohol or drugs Yes No
   d. Other moving violation Yes No

   If yes please specify: _____

10. In the past week how many walks did you take outside (including walking the dog and walks for exercise)? Number of walks _____

11. In the past week how much time did you spend walking?

_____ hours _____minutes

12. Were any of the walks you took in the past week

Circle the correct response for each

| | | | |
|---|---|---|---|
| a. | To walk or exercise the dog | Yes | No |
| b. | On the way to or from work | Yes | No |
| c. | On the way to or from school | Yes | No |
| d. | On the way to or from public transportation | Yes | No |
| e. | Escorting children to or from school | Yes | No |
| f. | To shop or run errands | Yes | No |
| g. | For exercise | Yes | No |
| h. | For any other reason | Yes | No |

If yes please specify: _____

Office use only

Please check one box only unless otherwise indicated (do not write in boxes at right margin).

Please answer the following questions on the basis of your usual or typical feelings about driving. Each question asks you to answer according to how strongly you agree with one or other of two alternative answers. Please read each of the two alternatives carefully before answering. To answer, mark the horizontal line at the point which expresses your answer most accurately. Be sure to answer all the questions, even if some of them don't seem to apply to you very well: guess as best you can if need be.

Example: Are you a confident driver?

The more confident you are, the closer to the 'very much' alternative you should mark your cross. If you are quite a confident driver you would mark it like this:

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

1. Does it worry you to drive in bad weather?

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

2. I am disturbed by thoughts of having an accident or the car breaking down

very rarely 0 1 2 3 4 5 6 7 8 9 10 very often

3. Do you lose your temper when another driver does something silly?

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

4. Do you think you have enough experience and training to deal with risky situations on the road safely?

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

5. I find myself worrying about my mistakes and the things I do badly when driving

very rarely 0 1 2 3 4 5 6 7 8 9 10 very often

6. I would like to risk my life as a racing driver

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

7. My driving would be worse than usual in an unfamiliar rental car

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

8. I sometimes like to frighten myself a little while driving

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

9. I get a real thrill out of driving fast

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

10. I make a point of carefully checking every side road I pass for emerging vehicles

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

11. Driving brings out the worst in people

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

12. Do you think it is worthwhile taking risks on the road?

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

13. At times, I feel like I really dislike other drivers who cause problems for me

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

14. Advice on driving from a passenger is generally:

useful 0 1 2 3 4 5 6 7 8 9 10 unnecessary

15. I like to raise my adrenaline levels while driving

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

16. It's important to show other drivers that they can't take advantage of you

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

17. Do you feel confident in your ability to avoid an accident?

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

18. Do you usually make an effort to look for potential hazards when driving?

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

19. Other drivers are generally to blame for any difficulties I have on the road

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

20. I would enjoy driving a sports car on a road with no speed-limit

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

21. Do you find it difficult to control your temper when driving?

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

22. When driving on an unfamiliar road do you become more tense than usual?

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

23. I make a special effort to be alert even on roads I know well

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

24. I enjoy the sensation of accelerating rapidly

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

25. If I make a minor mistake when driving, I feel it's something I should be concerned about

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

26. I always keep an eye on parked cars in case somebody gets out of them, or there are pedestrians behind them

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

27. I feel more anxious than usual when I have a passenger in the car

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

28. I become annoyed if another car follows very close behind mine for some distance

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

29. I make an effort to see what's happening on the road a long way ahead of me

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

30. I try very hard to look out for hazards even when it's not strictly necessary

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

31. Are you usually patient during the rush hour?

very much 0 1 2 3 4 5 6 7 8 9 10 not at all

32. When you pass another vehicle do you feel in command of the situation?

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

33. When you pass another vehicle do you feel tense or nervous?

not at all 0 1 2 3 4 5 6 7 8 9 10 very much

34. Does it annoy you to drive behind a slow moving vehicle?

very much 0 1 2 3 4 5 6 7 8 9 10 not at all ☐☐

35. When you're in a hurry, other drivers usually get in your way

not at all 0 1 2 3 4 5 6 7 8 9 10 very much ☐☐

36. When I come to negotiate a difficult stretch of road, I am on the alert

very much 0 1 2 3 4 5 6 7 8 9 10 not at all ☐☐

37. Do you feel more anxious than usual when driving in heavy traffic?

not at all 0 1 2 3 4 5 6 7 8 9 10 very much ☐☐

38. I enjoy cornering at high speed

not at all 0 1 2 3 4 5 6 7 8 9 10 very much ☐☐

39. Are you annoyed when the traffic lights change to red when you approach them?

very much 0 1 2 3 4 5 6 7 8 9 10 not at all ☐☐

40. Does driving <u>usually</u> make you feel aggressive?

very much 0 1 2 3 4 5 6 7 8 9 10 not at all ☐☐

41. Think about how you feel when you have to drive for several hours, with few or no breaks from driving. How do your feelings <u>change</u> during the course of the drive?

a) More uncomfortable physically (e.g. headache or muscle pains) 0 1 2 3 4 5 6 7 8 9 10 No change

b) More drowsy or sleepy 0 1 2 3 4 5 6 7 8 9 10 No change

c) Maintain speed of reaction 0 1 2 3 4 5 6 7 8 9 10 Reactions to other traffic increasingly slow

d) Maintain attention to road-signs 0 1 2 3 4 5 6 7 8 9 10 Become increasingly inattentive to road-signs

e) Normal vision 0 1 2 3 4 5 6 7 8 9 10 Your vision becomes less clear

f) Increasingly difficult to judge your speed 0 1 2 3 4 5 6 7 8 9 10 Normal judgement of speed

g) Interest in driving does not change 0 1 2 3 4 5 6 7 8 9 10 Increasingly bored and fed-up

h) Passing becomes increasingly risky and dangerous 0 1 2 3 4 5 6 7 8 9 10 No change

---

Office use only a) ☐☐ b) ☐☐ c) ☐☐ d) ☐☐ e) ☐☐ f) ☐☐ g) ☐☐ h) ☐☐

# DCQ

These questions are concerned with how you usually deal with driving when it is difficult, stressful or upsetting. Think of those occasions during the last year when driving was particularly stressful. Perhaps you nearly had an accident, or you were stuck in a traffic jam, or you had to drive for a long time in poor visibility and heavy traffic. Use your experiences of driving during the last year to indicate how much you usually engage in the following activities when driving is difficult, stressful or upsetting, by CIRCLING one of the numbers from 0 to 5 to the right of each question.

| | Not at all | | | | | Very much |
|---|---|---|---|---|---|---|
| 1. Relieved my feelings by taking risks or driving fast | 0 | 1 | 2 | 3 | 4 | 5 |
| 2. Cheered myself up by thinking about things unrelated to the drive | 0 | 1 | 2 | 3 | 4 | 5 |
| 3. Stayed detached or distanced from the situation | 0 | 1 | 2 | 3 | 4 | 5 |
| 4. Tried to make other drivers more aware of me by driving close behind them | 0 | 1 | 2 | 3 | 4 | 5 |
| 5. Wished that I was a more confident and forceful driver | 0 | 1 | 2 | 3 | 4 | 5 |
| 6. Ignored my feelings about the drive | 0 | 1 | 2 | 3 | 4 | 5 |
| 7. Made sure I avoided reckless or impulsive actions | 0 | 1 | 2 | 3 | 4 | 5 |
| 8. Showed other drivers what I thought of them | 0 | 1 | 2 | 3 | 4 | 5 |
| 9. Drove assertively or aggressively | 0 | 1 | 2 | 3 | 4 | 5 |
| 10. Tried to gain something worthwhile from the drive | 0 | 1 | 2 | 3 | 4 | 5 |
| 11. Showed other drivers I was in control of the situation | 0 | 1 | 2 | 3 | 4 | 5 |
| 12. Made an extra effort to drive safely | 0 | 1 | 2 | 3 | 4 | 5 |
| 13. Felt that I was becoming a more experienced driver | 0 | 1 | 2 | 3 | 4 | 5 |
| 14. Made an effort to stay calm and relaxed | 0 | 1 | 2 | 3 | 4 | 5 |
| 15. Swore at other drivers (aloud or silently) | 0 | 1 | 2 | 3 | 4 | 5 |
| 16. Thought about good times I've had | 0 | 1 | 2 | 3 | 4 | 5 |
| 17. Wished that I found driving more enjoyable | 0 | 1 | 2 | 3 | 4 | 5 |
| 18. Made sure I kept a safe distance from the car in front | 0 | 1 | 2 | 3 | 4 | 5 |
| 19. Went on as if nothing had happened | 0 | 1 | 2 | 3 | 4 | 5 |
| 20. Refused to believe that anything unpleasant had happened | 0 | 1 | 2 | 3 | 4 | 5 |
| 21. Told myself there wasn't really any problem | 0 | 1 | 2 | 3 | 4 | 5 |
| 22. Let other drivers know they were at fault | 0 | 1 | 2 | 3 | 4 | 5 |
| 23. Criticised myself for not driving better | 0 | 1 | 2 | 3 | 4 | 5 |
| 24. Thought about the consequences of having an accident | 0 | 1 | 2 | 3 | 4 | 5 |
| 25. Flashed the car lights or used the horn in anger | 0 | 1 | 2 | 3 | 4 | 5 |
| 26. Felt I was learning how to cope with stress | 0 | 1 | 2 | 3 | 4 | 5 |
| 27. Deliberately slowed down when I met a difficult traffic situation or bad weather | 0 | 1 | 2 | 3 | 4 | 5 |
| 28. Made a special effort to look out for hazards | 0 | 1 | 2 | 3 | 4 | 5 |
| 29. Blamed myself for getting too emotional or upset | 0 | 1 | 2 | 3 | 4 | 5 |
| 30. Concentrated hard on what I had to do next | 0 | 1 | 2 | 3 | 4 | 5 |
| 31. Worried about what I was going to do next | 0 | 1 | 2 | 3 | 4 | 5 |
| 32. Looked on the drive as a useful experience | 0 | 1 | 2 | 3 | 4 | 5 |
| 33. Worried about my shortcomings as a driver | 0 | 1 | 2 | 3 | 4 | 5 |
| 34. Thought about the benefits I would get from making the journey | 0 | 1 | 2 | 3 | 4 | 5 |
| 35. Learnt from my mistakes | 0 | 1 | 2 | 3 | 4 | 5 |

**How Accurately Can You Describe Yourself?**

Please use this list of common human traits to describe yourself as accurately as possible. Describe yourself as you see yourself at the present time, not as you wish to be in the future. Describe yourself as you are generally or typically, as compared with other persons you know of the same sex and of roughly your same age.

For each question, ask yourself: "does this word apply to me"? Then CIRCLE a number to indicate how accurately each adjective describes you, using the following rating scale:

| 1<br>Extremely Inaccurate (does not apply at all) | 2<br>Very Inaccurate | 3<br>Moderately Inaccurate | 4<br>Slightly Inaccurate | 5<br>Neither Accurate nor Inaccurate (or unsure) | 6<br>Slightly Accurate | 7<br>Moderately Accurate | 8<br>Very Accurate | 9<br>Extremely Accurate (applies very strongly) |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bashful | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Energetic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Moody | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Systematic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Bold | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Envious | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Organized | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Talkative | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Careless | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Extraverted | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Philosophical | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Temperamental | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Cold | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Fretful | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Practical | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Touchy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Complex | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Harsh | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Quiet | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Uncreative | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Cooperative | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Imaginative | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Relaxed | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Unenvious | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Creative | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Inefficient | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Rude | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Unintellectual | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Deep | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Intellectual | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Shy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Unsympathetic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Disorganized | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Jealous | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Sloppy | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Warm | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Efficient | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Kind | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Sympathetic | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | Withdrawn | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

## Road Rage Survey

Circle the response that you think best describes drivers in your metropolitan area (e.g., Cincinnati)

1. In terms of rude drivers, how do you think the drivers in your metro area compare with drivers in other major cities? More same less

| | | |
|---|---|---|
| More rude than drivers in other cities | Same | Less rude than drivers in other cities |

2. How often do you see this among other drivers in your metro area: drivers cutting into your lane with little or no warning/notice?

| | | | | |
|---|---|---|---|---|
| Everyday | Several times/ week | Once a week | Once in a while | Never |

3. How often do you see this among other drivers in your metro area: drivers who tailgate?

| | | | | |
|---|---|---|---|---|
| Everyday | Several times/ week | Once a week | Once in a while | Never |

4. How often do you see this among other drivers in your metro area: drivers who slam on their brakes at the last minute?

| | | | | |
|---|---|---|---|---|
| Everyday | Several times/ week | Once a week | Once in a while | Never |

5. How often do you see this among other drivers in your metro area: drivers who run right through a light that has already turned red?

| | | | | |
|---|---|---|---|---|
| Everyday | Several times/ week | Once a week | Once in a while | Never |

6. How often do you see this among other drivers in your metro area: drivers driving a lot faster is safe for road or traffic conditions?

| | | | | |
|---|---|---|---|---|
| Everyday | Several times/ week | Once a week | Once in a while | Never |

7. How often do you see this among other drivers in your metro area: drivers who are talking on their cell phone?

| | | | | |
|---|---|---|---|---|
| Everyday | Several times/ week | Once a week | Once in a while | Never |

8. How often do you see this among other drivers in your metro area: drivers doing other things like putting on makeup, shaving or reading while driving?

| | | | | |
|---|---|---|---|---|
| Everyday | Several times/ week | Once a week | Once in a while | Never |

## PERSONALITY QUESTIONNAIRE

This questionnaire is concerned with what you are like in everyday life, i.e., how you *typically* act and feel about things. The questions are set out in several sections. Please read the instructions for each section carefully before you begin. Please also read each question carefully, and, for each one, circle the number response that best represents your opinion. We ask that you try to answer **all** the questions. You should also aim to work quickly without dwelling for a long time on any individual question.

### SECTION I

For each statement, please choose one of the following answers, according to how much you agree with the statement.

0 = Strongly disagree, 1 = Disagree somewhat, 2 = Neither agree nor disagree, 3 = Agree somewhat, 4 = Strongly agree

| | Strongly Disagree | | | | Strongly Agree |
|---|---|---|---|---|---|
| 1. I have occasionally thought that I had special, almost magical powers. | 0 | 1 | 2 | 3 | 4 |
| 2. I get so 'carried away' by new and exciting ideas that I never think of possible snags. | 0 | 1 | 2 | 3 | 4 |
| 3. I would enjoy fast driving. | 0 | 1 | 2 | 3 | 4 |
| 4. I would enjoy parachute jumping. | 0 | 1 | 2 | 3 | 4 |
| 5. A passing thought can seem so real it frightens me. | 0 | 1 | 2 | 3 | 4 |
| 6. Ideas and insights sometimes come to me so fast that I cannot express them all. | 0 | 1 | 2 | 3 | 4 |
| 7. My thoughts are sometimes so strong that I can almost hear them. | 0 | 1 | 2 | 3 | 4 |
| 8. I often get into a jam because I do things without thinking. | 0 | 1 | 2 | 3 | 4 |
| 9. I generally seek new and exciting experiences and sensations. | 0 | 1 | 2 | 3 | 4 |
| 10. I think that I could learn to read other's minds if I wanted to. | 0 | 1 | 2 | 3 | 4 |
| 11. I sometimes like doing things that are a bit frightening. | 0 | 1 | 2 | 3 | 4 |
| 12. I have occasionally sensed an evil presence around me even though I could not see it. | 0 | 1 | 2 | 3 | 4 |
| 13. I generally do and say things without stopping to think. | 0 | 1 | 2 | 3 | 4 |
| 14. I often do things on the spur of the moment. | 0 | 1 | 2 | 3 | 4 |
| 15. I feel that mysterious forces can cause me to have accidents. | 0 | 1 | 2 | 3 | 4 |
| 16. I mostly speak before thinking things out. | 0 | 1 | 2 | 3 | 4 |
| 17. I often get involved in things I later wish I could get out of. | 0 | 1 | 2 | 3 | 4 |
| 18. I usually work quickly without bothering to check. | 0 | 1 | 2 | 3 | 4 |
| 19. I welcome new and exciting experiences and sensations, even if they are a little frightening and unconventional. | 0 | 1 | 2 | 3 | 4 |
| 20. I am an impulsive person. | 0 | 1 | 2 | 3 | 4 |
| 21. I would enjoy the sensation of skiing very fast down a high mountain slope. | 0 | 1 | 2 | 3 | 4 |
| 22. I sometimes have a sense of vague danger or sudden dread for reasons that I do not understand. | 0 | 1 | 2 | 3 | 4 |
| 23. I quite enjoy taking risks. | | | | | |
| 24. I would like to go scuba diving. | 0 | 1 | 2 | 3 | 4 |

## SECTION II (Minor mistakes)

The following questions are about minor mistakes which everyone makes from time to time, but some of which happen more often than others. We want to know how often these things have happened to you in the past 6 months.

Please circle the appropriate number, where 0 = never, 1 = very rarely, 2 = occasionally, 3 = quite often, and 4 = very often.

| | Never | | | | Very Often |
|---|---|---|---|---|---|
| 1. Do you read something and find that you haven't been thinking about it? | 0 | 1 | 2 | 3 | 4 |
| 2. Do you find you forget why you went from one part of the house to the other? | 0 | 1 | 2 | 3 | 4 |
| 3. Do you fail to notice signposts on the road? | 0 | 1 | 2 | 3 | 4 |
| 4. Do you find you confuse right and left when giving directions? | 0 | 1 | 2 | 3 | 4 |
| 5. Do you have trouble making up your mind? | 0 | 1 | 2 | 3 | 4 |
| 6. Do you daydream when you ought to be listening to something? | 0 | 1 | 2 | 3 | 4 |
| 7. Do you start doing one thing at home and get distracted into doing something else? | 0 | 1 | 2 | 3 | 4 |
| 8. Do you find you can't quite remember something, although it's "on the tip of your tongue"? | 0 | 1 | 2 | 3 | 4 |
| 9. Do you find you can't think of anything to say? | 0 | 1 | 2 | 3 | 4 |

## SECTION III (Sleep habits)

The following questions relate to your usual sleep habits **during the past month only**. Your answers should indicate the most accurate reply for the majority of days and nights **in the past month**.

**During the past month:**

1. How long (in minutes) has it taken you to fall asleep each night?_____ [write number of minutes]

2. How many hours of actual sleep do you get each night (this may be different from the number of hours you spend in bed)_____ [write number of hours]

3. During the past month, how would you rate your sleep quality overall?
   Very good (0) Fairly good (1) Fairly bad (2) Very bad (3) [Circle one answer]

4. Next, please rate the sources or causes of any sleep disturbance you may have experienced during the last month. For each item (a) – (j), circle one of the numbers from 0 – 4, where:

0 = "Not during the past month", 1 = "Less than once a week", 2 = "Once or twice a week", and 3 = "Three or more times a week".

During the past month, how often have you had trouble sleeping because you:

| | | | | |
|---|---|---|---|---|
| (a) Cannot get to sleep within 30 minutes | 0 | 1 | 2 | 3 |
| (b) Wake up in the middle of the night or early morning | 0 | 1 | 2 | 3 |
| (c) Have to get up to use the bathroom | 0 | 1 | 2 | 3 |
| (d) Cannot breathe comfortably | 0 | 1 | 2 | 3 |
| (e) Cough or snore loudly | 0 | 1 | 2 | 3 |
| (f) Feel too cold | 0 | 1 | 2 | 3 |
| (g) Feel too hot | 0 | 1 | 2 | 3 |
| (h) Have bad dreams | 0 | 1 | 2 | 3 |
| (i) Have pain | 0 | 1 | 2 | 3 |
| (j) Cannot sleep for other reasons | 0 | 1 | 2 | 3 |

## DSSQ-3 STATE QUESTIONNAIRE

## PRE-TASK QUESTIONNAIRE

Instructions. This questionnaire is concerned with your feelings and thoughts at the moment. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you feel **AT THE MOMENT**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

For each statement, circle an answer from 0 to 4, so as to indicate how accurately it describes your feelings **AT THE MOMENT**.

**Definitely false = 0, Somewhat false = 1,**
**Neither true nor false = 2, Somewhat true = 3, Definitely true = 4**

| | | | | | |
|---|---|---|---|---|---|
| 1. I feel concerned about the impression I am making. | 0 | 1 | 2 | 3 | 4 |
| 2. I feel relaxed. | 0 | 1 | 2 | 3 | 4 |
| 3. The content of the task will be dull. | 0 | 1 | 2 | 3 | 4 |
| 4. I am thinking about how other people might judge my performance. | 0 | 1 | 2 | 3 | 4 |
| 5. I am determined to succeed on the task. | 0 | 1 | 2 | 3 | 4 |
| 6. I feel tense. | 0 | 1 | 2 | 3 | 4 |
| 7. I am worried about what other people think of me. | 0 | 1 | 2 | 3 | 4 |
| 8. I am thinking about how I would feel if I were told how I performed | 0 | 1 | 2 | 3 | 4 |
| 9. Generally, I feel in control of things. | 0 | 1 | 2 | 3 | 4 |
| 10. I am reflecting about myself. | 0 | 1 | 2 | 3 | 4 |
| 11. My attention will be directed towards the task. | 0 | 1 | 2 | 3 | 4 |
| 12. I am thinking deeply about myself. | 0 | 1 | 2 | 3 | 4 |
| 13. I feel energetic. | 0 | 1 | 2 | 3 | 4 |
| 14. I am thinking about things that happened to me in the past | 0 | 1 | 2 | 3 | 4 |
| 15. I am thinking about how other people might perform on this task | 0 | 1 | 2 | 3 | 4 |
| 16. I am thinking about something that happened earlier today. | 0 | 1 | 2 | 3 | 4 |
| 17. I expect that the task will be too difficult for me. | 0 | 1 | 2 | 3 | 4 |
| 18. I will find it hard to keep my concentration on the task. | 0 | 1 | 2 | 3 | 4 |
| 19. I am thinking about personal concerns and interests. | 0 | 1 | 2 | 3 | 4 |
| 20. I feel confident about my performance. | 0 | 1 | 2 | 3 | 4 |
| 21. I am examining my motives. | 0 | 1 | 2 | 3 | 4 |
| 22. I can handle any difficulties I may encounter | 0 | 1 | 2 | 3 | 4 |
| 23. I am thinking about how I have dealt with similar tasks in the past | 0 | 1 | 2 | 3 | 4 |
| 24. I am reflecting on my reasons for doing the task | 0 | 1 | 2 | 3 | 4 |
| 25. I am motivated to try hard at the task. | 0 | 1 | 2 | 3 | 4 |
| 26. I am thinking about things important to me. | 0 | 1 | 2 | 3 | 4 |
| 27. I feel uneasy. | 0 | 1 | 2 | 3 | 4 |
| 28. I feel tired. | 0 | 1 | 2 | 3 | 4 |
| 29. I feel that I cannot deal with the situation effectively. | 0 | 1 | 2 | 3 | 4 |
| 30. I feel bored. | 0 | 1 | 2 | 3 | 4 |

## DSSQ-3 STATE QUESTIONNAIRE

## POST-TASK QUESTIONNAIRE

Instructions. This questionnaire is concerned with your feelings and thoughts while you were performing the task. Please answer **every** question, even if you find it difficult. Answer, as honestly as you can, what is true of **you**. Please do not choose a reply just because it seems like the 'right thing to say'. Your answers will be kept entirely confidential. Also, be sure to answer according to how you felt **WHILE PERFORMING THE TASK**. Don't just put down how you usually feel. You should try and work quite quickly: there is no need to think very hard about the answers. The first answer you think of is usually the best.

For each statement, circle an answer from 0 to 4, so as to indicate how accurately it describes your feelings **WHILE PERFORMING THE TASK**.

**Definitely false = 0, Somewhat false = 1,**
**Neither true nor false = 2, Somewhat true = 3, Definitely true = 4**

| | | | | | |
|---|---|---|---|---|---|
| 1. I felt concerned about the impression I am making. | 0 | 1 | 2 | 3 | 4 |
| 2. I felt relaxed. | 0 | 1 | 2 | 3 | 4 |
| 3. The content of the task was dull. | 0 | 1 | 2 | 3 | 4 |
| 4. I thought about how other people might judge my performance | 0 | 1 | 2 | 3 | 4 |
| 5. I was determined to succeed on the task. | 0 | 1 | 2 | 3 | 4 |
| 6. I felt tense. | 0 | 1 | 2 | 3 | 4 |
| 7. I was worried about what other people think of me. | 0 | 1 | 2 | 3 | 4 |
| 8. I thought about how I would felt if I were told how I performed | 0 | 1 | 2 | 3 | 4 |
| 9. Generally, I felt in control of things. | 0 | 1 | 2 | 3 | 4 |
| 10. I reflected about myself. | 0 | 1 | 2 | 3 | 4 |
| 11. My attention was directed towards the task. | 0 | 1 | 2 | 3 | 4 |
| 12. I thought deeply about myself. | 0 | 1 | 2 | 3 | 4 |
| 13. I felt energetic. | 0 | 1 | 2 | 3 | 4 |
| 14. I thought about things that happened to me in the past | 0 | 1 | 2 | 3 | 4 |
| 15. I thought about how other people might perform on this task | 0 | 1 | 2 | 3 | 4 |
| 16. I thought about something that happened earlier today. | 0 | 1 | 2 | 3 | 4 |
| 17. I found the task was too difficult for me. | 0 | 1 | 2 | 3 | 4 |
| 18. I found it hard to keep my concentration on the task. | 0 | 1 | 2 | 3 | 4 |
| 19. I thought about personal concerns and interests. | 0 | 1 | 2 | 3 | 4 |
| 20. I felt confident about my performance. | 0 | 1 | 2 | 3 | 4 |
| 21. I examined my motives. | 0 | 1 | 2 | 3 | 4 |
| 22. I felt like I could handle any difficulties I encountered | 0 | 1 | 2 | 3 | 4 |
| 23. I thought about how I have dealt with similar tasks in the past | 0 | 1 | 2 | 3 | 4 |
| 24. I reflected on my reasons for doing the task | 0 | 1 | 2 | 3 | 4 |
| 25. I was motivated to try hard at the task. | 0 | 1 | 2 | 3 | 4 |
| 26. I thought about things important to me. | 0 | 1 | 2 | 3 | 4 |
| 27. I felt uneasy. | 0 | 1 | 2 | 3 | 4 |
| 28. I felt tired. | 0 | 1 | 2 | 3 | 4 |
| 29. I felt that I could not deal with the situation effectively. | 0 | 1 | 2 | 3 | 4 |
| 30. I felt bored. | 0 | 1 | 2 | 3 | 4 |

**Pedestrian Perspective Questionnaire**

Base your answers to the following questions on your opinions of the scenario and roadway scene depicted on the previous page.
Please **CIRCLE** your response to each question.

**Part 1: Intersection Characteristics**

| | Strongly disagree | | | | | Strongly agree |
|---|---|---|---|---|---|---|
| 1. This area would be a good place to cross the road | 0 | 1 | 2 | 3 | 4 | 5 |
| 2. I would feel comfortable crossing here without a marked crosswalk | 0 | 1 | 2 | 3 | 4 | 5 |
| 3. It would be safe to cross this road even if the "Don't Walk" sign were illuminated | 0 | 1 | 2 | 3 | 4 | 5 |
| 4. It would be safe to cross this road at a location other than the intersection | 0 | 1 | 2 | 3 | 4 | 5 |
| 5. I would feel comfortable as a pedestrian with cars approaching at this speed | 0 | 1 | 2 | 3 | 4 | 5 |
| 6. I would rate this as a safe intersection | 0 | 1 | 2 | 3 | 4 | 5 |

**Part II: Driver Behaviors**

| | | | | | | |
|---|---|---|---|---|---|---|
| 7. This behavior would make me feel uneasy | 0 | 1 | 2 | 3 | 4 | 5 |
| 8. I find this behavior to be aggressive | 0 | 1 | 2 | 3 | 4 | 5 |
| 9. I find this behavior to be threatening | 0 | 1 | 2 | 3 | 4 | 5 |
| 10. These behaviors would help me feel safe while crossing the street | 0 | 1 | 2 | 3 | 4 | 5 |
| 11. I would be confident that the drivers would do nothing to threaten my safety | 0 | 1 | 2 | 3 | 4 | 5 |
| 12. I would be able to choose a time to cross safely | 0 | 1 | 2 | 3 | 4 | 5 |
| 13. The drivers would be fully aware of my presence at the cross-walk | 0 | 1 | 2 | 3 | 4 | 5 |
| 14. The drivers would have full control of their vehicles | 0 | 1 | 2 | 3 | 4 | 5 |
| 15. This behavior is acceptable at this type of intersection | 0 | 1 | 2 | 3 | 4 | 5 |
| 16. These types of driver behaviors are not fair to the rights of pedestrians | 0 | 1 | 2 | 3 | 4 | 5 |
| 17. These driver behaviors should result in a citation from law enforcement | 0 | 1 | 2 | 3 | 4 | 5 |
| 18. Traffic laws should be strengthened to prevent these types of driver behaviors | 0 | 1 | 2 | 3 | 4 | 5 |

**Part III: Safety Countermeasures. For this section please base your answers on how effective you think the safety countermeasure would be in increasing pedestrian safety given the scenario and intersection presented in the previous page.**

| | Not Effective | | | | | Very Effective |
|---|---|---|---|---|---|---|
| 19. Design crosswalks to increase the distance between vehicles and pedestrians | 0 | 1 | 2 | 3 | 4 | 5 |
| 20. Create bulb outs in sidewalks to decrease the distance that a pedestrian needs to be in the roadway | 0 | 1 | 2 | 3 | 4 | 5 |
| 21. Have refuge islands in the middle of roadways with 4 or more lanes | 0 | 1 | 2 | 3 | 4 | 5 |
| 22. Increase signal cycle times to reduce the time pedestrians have to wait to cross the road | 0 | 1 | 2 | 3 | 4 | 5 |
| 23. Create more pedestrian boulevards that prohibit automobile traffic | 0 | 1 | 2 | 3 | 4 | 5 |
| 24. Create pedestrian overpasses to eliminate pedestrian delay and enhance safety | 0 | 1 | 2 | 3 | 4 | 5 |
| 25. Lower speed limits in the vicinity of crosswalks | 0 | 1 | 2 | 3 | 4 | 5 |
| 26. Place speed humps close to crosswalks in order to slow traffic | 0 | 1 | 2 | 3 | 4 | 5 |
| 27. Create more frequent safe crossing places along busy streets | 0 | 1 | 2 | 3 | 4 | 5 |
| 28. Give drivers more advanced warning of crosswalks | 0 | 1 | 2 | 3 | 4 | 5 |
| 29. Increase the visibility of crosswalks | 0 | 1 | 2 | 3 | 4 | 5 |
| 30. Have pedestrian actuated barriers, similar to railroad crossings, to protect pedestrians | 0 | 1 | 2 | 3 | 4 | 5 |
| 31. Have call boxes at crosswalks so that drivers who intimidate pedestrians can be reported to law enforcement | 0 | 1 | 2 | 3 | 4 | 5 |
| 32. Allow pedestrians to adjust the length of a traffic signal to allow more crossing time if needed. | 0 | 1 | 2 | 3 | 4 | 5 |
| 33. Increase traffic law enforcement in the vicinity of crosswalks | 0 | 1 | 2 | 3 | 4 | 5 |
| 34. Increase penalties for violations in the vicinity of crosswalks | 0 | 1 | 2 | 3 | 4 | 5 |
| 35. Use cameras to detect violations in the vicinity of crosswalks | 0 | 1 | 2 | 3 | 4 | 5 |
| 36. Educate drivers in safer driving at crosswalks | 0 | 1 | 2 | 3 | 4 | 5 |
| 37. Implement a public awareness campaign that explains appropriate crosswalk behaviors for both drivers and pedestrians | 0 | 1 | 2 | 3 | 4 | 5 |
| 38. Reward good driving behaviors with an incentive program such as discounts on auto insurance | 0 | 1 | 2 | 3 | 4 | 5 |

## APPENDIX D:

## Safety Appraisal Descriptive Statistics

| Driver Behaviors | | | | |
|---|---|---|---|---|
| | | Safe | Distracted | Aggressive |
| Safety | *M* | 14.262 | 12.500 | 14.133 |
| | *SD* | 9.280 | 9.065 | 9.105 |
| | | | | |
| Driver Threat | *M* | 7.224 | 8.351 | 7.887 |
| | *SD* | 5.158 | 4.901 | 5.377 |
| | | | | |
| Control | *M* | 12.870 | 10.980 | 12.230 |
| | *SD* | 7.011 | 6.772 | 7.354 |
| | | | | |
| Norms | *M* | 9.634 | 11.110 | 10.205 |
| | *SD* | 6.617 | 6.201 | 6.576 |

| Intersection Threat | | | | |
|---|---|---|---|---|
| | | 2 lane 25MPH | 4 lane 35MPH | 4 lane 45MPH |
| Safety | *M* | 16.928 | 13.776 | 10.176 |
| | *SD* | 9.420 | 8.540 | 8.276 |
| | | | | |
| Driver Threat | *M* | 7.277 | 7.775 | 8.408 |
| | *SD* | 5.140 | 5.117 | 5.188 |
| | | | | |
| Control | *M* | 13.013 | 12.232 | 10.821 |
| | *SD* | 7.183 | 6.928 | 6.993 |
| | | | | |
| Norms | *M* | 9.975 | 10.099 | 10.879 |
| | *SD* | 6.574 | 6.349 | 6.522 |

| | Overall *M* | Overall *SD* |
|---|---|---|
| This area would be a good place to cross the road | 2.67 | 1.77 |
| I would feel comfortable crossing here without a marked crosswalk | 2.19 | 1.76 |
| It would be safe to cross this road even if the "Don't Walk" sign were illuminated | 1.90 | 1.66 |
| It would be safe to cross this road at a location other than the intersection | 1.95 | 1.65 |
| I would feel comfortable as a pedestrian with cars approaching at this speed | 2.42 | 1.70 |
| I would rate this as a safe intersection | 2.50 | 1.74 |
| This behavior would make me feel uneasy | 2.84 | 1.83 |
| I find this behavior to be aggressive | 2.32 | 1.85 |
| I find this behavior to be threatening | 2.66 | 1.86 |
| These behaviors would help me feel safe while crossing the street | 2.07 | 1.81 |
| I would be confident that the drivers would do nothing to threaten my safety | 2.17 | 1.61 |
| I would be able to choose a time to cross safely | 3.09 | 1.57 |
| The drivers would be fully aware of my presence at the cross-walk | 2.33 | 1.62 |
| The drivers would have full control of their vehicles | 2.34 | 1.56 |
| This behavior is acceptable at this type of intersection | 2.18 | 1.83 |
| These types of driver behaviors are not fair to the rights of pedestrians | 2.65 | 1.83 |
| These driver behaviors should result in a citation from law enforcement | 2.41 | 1.79 |
| Traffic laws should be strengthened to prevent these types of driver behaviors | 2.42 | 1.84 |

Overall responses to safety appraisal items.

## APPENDIX E:

### Countermeasure Efficacy Descriptive Statistics

| Driver Behaviors | | | | |
|---|---|---|---|---|
| | | Safe | Distracted | Aggressive |
| Design | *M* | 21.703 | 22.803 | 22.354 |
| | *SD* | 9.421 | 9.288 | 9.535 |
| | | | | |
| Control | *M* | 14.217 | 14.527 | 14.244 |
| | *SD* | 5.581 | 5.392 | 5.728 |
| | | | | |
| Enforcement | *M* | 10.406 | 11.066 | 10.463 |
| | *SD* | 5.520 | 5.210 | 5.397 |
| | | | | |
| Education | *M* | 8.816 | 8.830 | 8.784 |
| | *SD* | 3.787 | 3.812 | 4.051 |

| Intersection Threat | | | | |
|---|---|---|---|---|
| | | 2 lane 25MPH | 4 lane 35MPH | 4 lane 45MPH |
| Design | *M* | 19.807 | 22.552 | 24.485 |
| | *SD* | 10.047 | 8.997 | 8.582 |
| | | | | |
| Control | *M* | 13.379 | 14.370 | 15.229 |
| | *SD* | 5.938 | 5.314 | 5.279 |
| | | | | |
| Enforcement | *M* | 10.003 | 10.558 | 11.376 |
| | *SD* | 5.600 | 5.271 | 5.186 |
| | | | | |
| Education | *M* | 8.501 | 8.840 | 9.087 |
| | *SD* | 3.963 | 3.832 | 3.836 |

# APPENDIX F:

## Factor Pattern Matrices

## Safety Appraisals

| | | Factor | | |
|---|---|---|---|---|
| | | **Safe** | **Distracted** | **Aggressive** |
| Safety | Safe 25 | **.772** | .026 | -.030 |
| Safety | Safe 35 | **.872** | .160 | -.058 |
| Safety | Safe 45 | **.788** | .170 | -.077 |
| Driver Threat | Safe 25 | **-.755** | .253 | -.169 |
| Driver Threat | Safe 35 | **-.832** | .170 | -.049 |
| Driver Threat | Safe 45 | **-.823** | .149 | -.060 |
| Control | Safe 25 | **.819** | -.090 | .123 |
| Control | Safe 35 | **.867** | .015 | .051 |
| Control | Safe 45 | **.818** | .043 | -.004 |
| Norms | Safe 25 | **-.765** | .125 | -.169 |
| Norms | Safe 35 | **-.797** | .149 | -.163 |
| Norms | Safe 45 | **-.837** | .111 | -.103 |
| Safety | Distracted 25 | .082 | **.691** | -.143 |
| Safety | Distracted 35 | .071 | **.828** | -.057 |
| Safety | Distracted 45 | .178 | **.856** | -.137 |
| Driver Threat | Distracted 25 | .152 | **-.783** | -.136 |
| Driver Threat | Distracted 35 | .134 | **-.775** | -.178 |
| Driver Threat | Distracted 45 | .096 | **-.780** | -.152 |
| Control | Distracted 25 | .022 | **.854** | -.029 |
| Control | Distracted 35 | -.021 | **.850** | .032 |
| Control | Distracted 45 | -.041 | **.863** | .009 |
| Norms | Distracted 25 | .182 | **-.719** | -.178 |
| Norms | Distracted 35 | .201 | **-.711** | -.220 |
| Norms | Distracted 45 | .119 | **-.776** | -.126 |
| Safety | Aggressive 25 | .005 | .069 | **-.749** |
| Safety | Aggressive 35 | .055 | .128 | **-.900** |
| Safety | Aggressive 45 | .160 | .175 | **-.860** |
| Driver Threat | Aggressive 25 | .167 | .165 | **.780** |
| Driver Threat | Aggressive 35 | .125 | .180 | **.820** |
| Driver Threat | Aggressive 45 | .111 | .140 | **.843** |
| Control | Aggressive 25 | -.086 | -.060 | **-.827** |
| Control | Aggressive 35 | -.118 | -.045 | **-.850** |
| Control | Aggressive 45 | .007 | -.011 | **-.873** |
| Norms | Aggressive 25 | .162 | .167 | **.741** |
| Norms | Aggressive 35 | .164 | .179 | **.764** |
| Norms | Aggressive 45 | .111 | .111 | **.758** |

## Countermeasure Efficacy

| | | Factor | | | |
|---|---|---|---|---|---|
| | | **Distracted** | **Safe** | **Aggressive** | **Education** |
| Design | Safe 25 | **0.699** | -0.005 | -0.278 | -0.094 |
| Design | Safe 35 | **0.729** | 0.081 | -0.219 | -0.094 |
| Design | Safe 45 | **0.617** | 0.206 | -0.221 | -0.115 |
| Control | Safe 25 | **0.716** | 0.090 | -0.182 | -0.100 |
| Control | Safe 35 | **0.696** | 0.072 | -0.202 | 0.016 |
| Control | Safe 45 | **0.664** | 0.210 | -0.135 | 0.002 |
| Enforcement | Safe 25 | **0.876** | -0.032 | 0.010 | 0.051 |
| Enforcement | Safe 35 | **0.883** | 0.021 | 0.044 | 0.066 |
| Enforcement | Safe 45 | **0.803** | 0.078 | 0.169 | 0.165 |
| Design | Distracted 25 | -0.053 | **0.691** | -0.255 | -0.053 |
| Design | Distracted 35 | -0.067 | **0.806** | -0.248 | -0.043 |
| Design | Distracted 45 | 0.002 | **0.790** | -0.204 | -0.003 |
| Control | Distracted 25 | -0.031 | **0.817** | -0.165 | -0.013 |
| Control | Distracted 35 | 0.040 | **0.820** | -0.082 | 0.038 |
| Control | Distracted 45 | 0.060 | **0.785** | -0.047 | 0.065 |
| Enforcement | Distracted 25 | 0.190 | **0.670** | 0.134 | 0.048 |
| Enforcement | Distracted 35 | 0.238 | **0.645** | 0.178 | 0.130 |
| Enforcement | Distracted 45 | 0.188 | **0.626** | 0.212 | 0.219 |
| Design | Aggressive 25 | 0.098 | 0.072 | **-0.784** | -0.020 |
| Design | Aggressive 35 | 0.016 | 0.140 | **-0.871** | -0.022 |
| Design | Aggressive 45 | 0.069 | 0.127 | **-0.818** | 0.021 |
| Control | Aggressive 25 | 0.014 | 0.069 | **-0.815** | 0.100 |
| Control | Aggressive 35 | 0.116 | 0.055 | **-0.822** | -0.020 |
| Control | Aggressive 45 | 0.089 | 0.159 | **-0.751** | -0.018 |
| Enforcement | Aggressive 25 | 0.118 | -0.025 | **-0.636** | 0.197 |
| Enforcement | Aggressive 35 | 0.083 | -0.045 | **-0.631** | 0.212 |
| Enforcement | Aggressive 45 | 0.106 | -0.050 | **-0.617** | 0.158 |
| Education | Safe 25 | 0.391 | -0.071 | -0.032 | **0.606** |
| Education | Safe 35 | 0.397 | -0.070 | -0.005 | **0.723** |
| Education | Safe 45 | 0.338 | -0.045 | 0.025 | **0.808** |
| Education | Distracted 25 | -0.111 | 0.435 | -0.047 | **0.609** |
| Education | Distracted 35 | -0.113 | 0.394 | -0.023 | **0.708** |
| Education | Distracted 45 | -0.120 | 0.353 | 0.068 | **0.776** |
| Education | Aggressive 25 | -0.142 | 0.091 | -0.332 | **0.738** |
| Education | Aggressive 35 | -0.129 | 0.061 | -0.229 | **0.837** |
| Education | Aggressive 45 | -0.168 | 0.026 | -0.315 | **0.791** |

## APPENDIX G:

## Correlational Matrices

### Safety Appraisal and Big Five Personality Factors

| | Extraversion | Agreeableness | Conscientiousness | Neuroticism | Openness |
|---|---|---|---|---|---|
| Safe | -.008 | .114 | -.025 | -.033 | -.020 |
| Distracted | .143* | -.126 | -.067 | .074 | -.100 |
| Aggressive | -.029 | .052 | .159* | -.150* | -.082 |

*Note: * p<.05, ** p <.01*

### Safety Appraisal and Specific Personality Factors

| | Unusual Experiences | Impulsivity | Sensation Seeking | Cognitive Failures | Sleep Disturbance (1) | Sleep Disturbance (3) | Sleep Disturbance (4) | Sleep Disturbance (5) |
|---|---|---|---|---|---|---|---|---|
| Safe | .002 | -.073 | -.035 | .016 | -.069 | -.059 | -.054 | -.076 |
| Distracted | -.114 | -.169** | -.172** | -.142* | -.085 | -.136* | -.124 | .020 |
| Aggressive | .198** | .186** | .194** | .152* | .263** | .216** | .227** | .079 |

*Note: * p<.05, ** p <.01*

**Safety Appraisal and Driver Stress Inventory (DSI) Factors**

| | Aggression | Dislike of Driving | Hazard Monitoring | Thrill Seeking | Fatigue Proneness |
|---|---|---|---|---|---|
| Safe | -.070 | .033 | -.082 | -.114 | .027 |
| Distracted | .037 | .088 | -.092 | -.105 | .146* |
| Aggressive | .086 | -.109 | .071 | -.073 | -.017 |

*Note: * p<.05, ** p <.01*

**Safety Appraisal and Driver Coping Questionnaire (DCQ) Factors**

| | Confrontive Coping | Emotion-focused Coping | Task-focused Coping | Reappraisal | Avoidance |
|---|---|---|---|---|---|
| Safe | .020 | .091 | .115 | .122 | -.025 |
| Distracted | .065 | .012 | .032 | .147* | .043 |
| Aggressive | .040 | .001 | .042 | .015 | -.144* |

*Note: * p<.05, ** p <.01*

**Safety Appraisal and Dundee Stress State Questionnaire (DSSQ) Factors**

| | Pre-Task | | | Post-Task | | |
|---|---|---|---|---|---|---|
| | Engagement | Distress | Worry | Engagement | Distress | Worry |
| Safe | .015 | -.087 | .173** | -.163* | .060 | -.061 |
| Distracted | .136* | -.105 | -.117 | .241** | -.020 | .002 |
| Aggressive | -.063 | .050 | .002 | -.194** | .021 | .168** |

*Note: * p<.05, ** p <.01*

**Countermeasure Efficacy and Big Five Personality Factors**

| | Extraversion | Agreeableness | Conscientiousness | Neuroticism | Openness |
|---|---|---|---|---|---|
| Safe | -.101 | -.139* | -.017 | -.003 | .117 |
| Distracted | -.259** | -.070 | -.052 | -.052 | .180** |
| Aggressive | -.058 | -.176** | -.170* | .140* | .168* |
| Education | -.091 | .065 | -.173** | -.025 | .159* |

*Note: * p<.05, ** p <.01*

**Countermeasure Efficacy and Specific Personality Factors**

| | Unusual Experiences | Impulsivity | Sensation Seeking | Cognitive Failures | Sleep Disturbance (1) | Sleep Disturbance (3) | Sleep Disturbance (4) | Sleep Disturbance (5) |
|---|---|---|---|---|---|---|---|---|
| Safe | -.056 | .125 | .095 | .044 | .104 | -.008 | -.008 | .027 |
| Distracted | -.093 | -.040 | -.038 | .105 | .089 | -.092 | -.090 | -.090 |
| Aggressive | -.242** | -.154* | -.202** | -.014 | -.026 | -.135* | -.142* | -.093 |
| Education | -.095 | -.025 | .017 | -.056 | -.005 | -.034 | -.003 | -.079 |

*Note: * p<.05, ** p <.01*

**Countermeasure Efficacy and Driver Stress Inventory (DSI) Factors**

| | Aggression | Dislike of Driving | Hazard Monitoring | Thrill Seeking | Fatigue Proneness |
|---|---|---|---|---|---|
| Safe | -.030 | .058 | .193** | .032 | -.122 |
| Distracted | -.180** | .013 | .202** | .048 | -.108 |
| Aggressive | -.078 | .067 | .108 | -.018 | .006 |
| Education | -.161* | .167** | -.075 | .129* | -.087 |

*Note: * p<.05, ** p <.01*

**Countermeasure Efficacy and Driver Coping Questionnaire (DCQ) Factors**

| | Confrontive Coping | Emotion-focused Coping | Task-focused Coping | Reappraisal | Avoidance |
|---|---|---|---|---|---|
| Safe | .003 | .012 | -.003 | -.077 | .042 |
| Distracted | -.084 | -.058 | -.079 | -.129 | -.085 |
| Aggressive | -.141* | -.195** | -.167* | -.208** | -.039 |
| Education | -.049 | -.111 | -.088 | -.189** | .039 |

*Note: * p<.05, ** p <.01*

**Countermeasure Efficacy and Dundee Stress State Questionnaire (DSSQ) Factors**

| | Pre-Task | | | Post-Task | | |
|---|---|---|---|---|---|---|
| | Engagement | Distress | Worry | Engagement | Distress | Worry |
| Safe | -.130 | .185** | .063 | .208** | -.059 | .204** |
| Distracted | -.237** | .058 | .088 | -.100 | .015 | .211** |
| Aggressive | -.154* | .066 | -.068 | .219** | -.044 | .007 |
| Education | -.105 | -.019 | .032 | .147* | -.093 | .181** |

*Note: * p<.05, ** p <.01*